MACHINIST'S PRACTICAL GUIDE

MORSE
TWIST DRILL & MACHINE CO.
NEW BEDFORD, MASS., U.S.A.

MACHINIST'S PRACTICAL GUIDE

THE

MORSE TWIST DRILL AND MACHINE CO.

INCORPORATED 1864

MAKERS OF

TWIST DRILLS, REAMERS, MILLING CUTTERS, TAPS, DIES, SOCKETS, GAUGES, CHUCKS, MACHINERY AND MACHINISTS' TOOLS

NEW BEDFORD, MASS.
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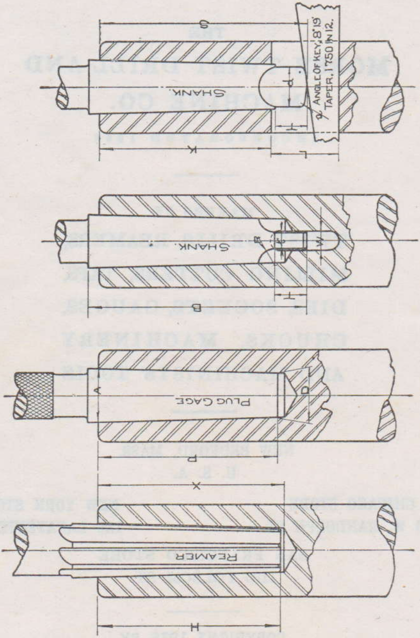
MORSE TAPERS



Number of Taper	Diam. of Plug at Small End	Diam. at End of Socket	SHANK Whole Length	SHANK Depth	Depth of Drilled Hole	Depth of Reamed Hole	Standard Plug Depth	TONGUE Thickness	TONGUE Length	TONGUE Radius	TONGUE Diameter	TONGUE Radius	KEYWAY Width	KEYWAY Length	End of Socket to Keyway	Taper Per Inch	Taper Per Foot	Number of Key
	D	A	B	S	X	H	P	t	T	R	d	a	W	L	K			
0	.252	.3561	2 11/32	2 7/32	2 1/16	2 1/32	2	.1562	1/4	5/32	.235	.04	.160	9/16	1 15/16	.052050	.62460	0
1	.369	475	2 9/16	2 7/16	2 3/16	2 5/32	2 1/8	2031	3/8	3/16	.343	.05	.213	3/4	2 1/16	.049882	.59858	1
2	.572	700	3 1/8	2 15/16	2 21/32	2 39/64	2 9/16	.250	7/16	1/4	17/32	.06	.260	7/8	2 1/2	.049951	.59941	2
3	.778	.938	3 7/8	3 11/16	3 5/16	3 1/4	3 3/16	.3125	9/16	9/32	23/32	.08	.322	1 3/16	3 1/16	.050196	.60235	3
4	1 020	1 231	4 7/8	4 5/8	4 3/16	4 1/8	4 1/16	.4687	5/8	5/16	31/32	.10	.478	1 1/4	3 7/8	.051938	.62326	4
4 1/2	1.266	1.500	5 3/8	5 1/8	4 5/8	4 9/16	4 1/2	.5625	11/16	3/8	1 13/64	.12	.573	1 3/8	4 5/16	.0520	.6240	
5	1.475	1.748	6 1/8	5 7/8	5 5/16	5 1/4	5 3/16	.6250	3/4	3/8	1 13/32	.12	.635	1 1/2	4 15/16	.052626	.63151	5
6	2.116	2.494	8 9/16	8 1/4	7 13/32	7 21/64	7 1/4	.750	1 1/8	1/2	2	.15	.760	1 3/4	7	.052137	.62565	6
7	2.750	3.270	11 5/8	11 1/4	10 5/32	10 5/64	10	1 125	1 3/8	3/4	2 5/8	.18	1.135	2 5/8	9 1/2	.05200	.6240	7

Speed and Feed
Carbon Steel Drills

Diam. of Drill, Inches	Revolutions Per Minute						Feed Per Revolution, Inches
	Brass	Cast Iron	Mild Steel .20–.30 Carbon	Steel .40–.50 Carbon and Malleable Iron	Tool Steel 1.20 Carbon Drop Forgings and 3.50 Nickel Steel	Stainless and Molybdenum Steels and Monel Metal	
	100 Ft.	50 Ft.	40 Ft.	35 Ft.	30 Ft.	25 Ft.	
1/16	6112	3056	2444	2140	1834	1528	.0015
1/8	3056	1528	1222	1070	917	764	.002–.003
3/16	2036	1018	815	714	611	509	.004
1/4	1528	764	611	535	458	382	.005
5/16	1222	611	489	428	367	306	.005
3/8	1018	509	408	357	306	255	.006
7/16	874	437	349	306	262	218	.007
1/2	764	382	306	268	229	191	.008
9/16	679	340	272	238	204	170	.008
5/8	612	306	245	214	184	153	.009
11/16	555	273	222	194	167	138	.009
3/4	508	254	203	178	153	127	.010
13/16	474	237	190	166	142	119	.010
7/8	438	219	175	153	131	109	.010
15/16	407	204	163	142	122	101	.010
1	382	191	153	134	115	95	.011
1 1/16	359	180	144	126	108	89	.011
1 1/8	340	170	136	119	102	85	.012
1 3/16	322	161	129	113	96	80	.012
1 1/4	306	153	123	107	91	76	.013
1 5/16	291	146	116	102	87	72	.013
1 3/8	278	139	111	97	83	69	.014
1 7/16	265	133	106	92	79	66	.014
1 1/2	254	127	102	89	76	63	.015
1 9/16	244	122	97	85	73	61	.015
1 5/8	234	117	94	82	70	58	.015
1 11/16	226	113	90	79	67	56	.015
1 3/4	218	109	87	76	65	54	.015
1 13/16	210	105	84	73	63	52	.015
1 7/8	204	102	81	71	61	50	.015
1 15/16	197	98	78	69	59	49	.015
2	191	95	76	66	57	47	.015

Speed and Feed
High Speed Steel Drills

*Soft Grade 50 Per Cent Faster

Diam. of Drill, Inches	Revolutions Per Minute					Tool Steel 1.20 Carbon and Drop Forgings	Feed Per Revolution, Inches
	Aluminum	Brass	Cast Iron*	Mild Steel .20–.30 Carbon	Steel .40–.50 Carbon		
	300 Ft.	200 Ft.	100 Ft.	110 Ft.	80 Ft.	60 Ft.	
1/16	18336	12224	6112	6724	4883	3668	.0015
1/8	9168	6112	3056	3362	2444	1834	.002–.003
3/16	6108	4072	2036	2242	1630	1222	.004
1/4	4584	3056	1528	1681	1222	917	.005
5/16	3666	2444	1222	1344	978	733	.005
3/8	3054	2036	1018	1121	815	611	.006
7/16	2622	1748	874	921	699	524	007
1/2	2292	1528	764	840	611	459	.008
9/16	2037	1358	679	747	543	407	.008
5/8	1836	1224	612	673	489	367	.009
11/16	1665	1110	555	611	444	333	009
3/4	1524	1016	508	559	408	306	.010
13/16	1422	948	474	521	379	284	.010
7/8	1314	876	438	482	349	262	.011
15/16	1221	814	407	448	326	244	.012
1	1146	764	382	420	306	229	.013
1 1/16	1077	718	359	395	287	215	.013
1 1/8	1020	680	340	374	272	204	014
1 3/16	966	644	322	354	258	193	014
1 1/4	918	612	306	337	245	183	.015
1 5/16	873	582	291	320	233	175	015
1 3/8	834	556	278	306	222	167	015
1 7/16	795	530	265	292	212	159	015
1 1/2	762	508	254	279	204	153	.015
1 9/16	732	488	244	268	195	146	.016
1 5/8	702	468	234	257	188	141	.016
1 11/16	678	452	226	249	181	136	016
1 3/4	654	436	218	240	175	131	.016
1 13/16	630	420	210	231	168	126	.016
1 7/8	612	408	204	224	163	122	.016
1 15/16	591	394	197	216	158	118	.016
2	573	382	191	210	153	115	.016

Speed and Feed

High Speed Steel Drills

Diam. of Drill, Inches	Revolutions Per Minute					Feed Per Revolution, Inches
	Conn. Rod Molybdenum Steel	3.50 Nickel Steel	Stainless Steel and Monel Metal	Malleable Iron	Slate	
	55 Ft.	65 Ft.	50 Ft.	85 Ft.	15 Ft.	
1/16	3404	3976	3056	5192	916	.0015
1/8	1702	1988	1528	2596	458	002-.003
3/16	1120	1324	1018	1734	306	.004
1/4	851	994	764	1298	229	.005
5/16	672	794	611	1039	184	.005
3/8	560	662	509	867	153	.006
7/16	481	568	437	742	131	.007
1/2	420	497	382	649	115	.008
9/16	373	441	340	577	102	.008
5/8	337	398	306	520	92	.009
11/16	300	360	273	472	84	.009
3/4	279	330	254	433	77	.010
13/16	261	308	237	403	71	.010
7/8	241	285	219	371	66	.011
15/16	224	265	204	346	61	.012
1	210	258	191	325	58	.013
1 1/16	197	233	180	305	54	.013
1 1/8	187	221	170	288	51	.014
1 3/16	177	209	161	274	48	.014
1 1/4	168	199	153	260	46	.015
1 5/16	160	189	146	248	44	.015
1 3/8	153	180	139	236	42	.015
1 7/16	146	172	133	225	40	.015
1 1/2	140	165	127	216	38	.015
1 9/16	134	159	122	207	37	.016
1 5/8	129	152	117	201	35	.016
1 11/16	124	147	113	192	34	.016
1 3/4	120	142	109	186	33	.016
1 13/16	116	137	105	179	32	.016
1 7/8	112	133	102	173	31	.016
1 15/16	108	128	99	168	30	.016
2	105	124	96	162	29	.016

SPEED AND FEED OF WIRE DRILLS

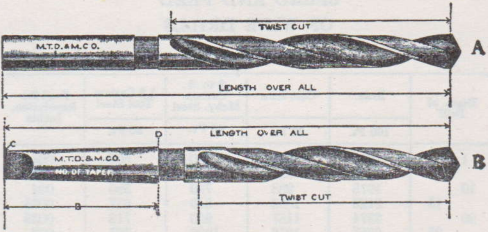
Carbon Steel Drills

Diam. of Drill	Brass	Cast Iron	.2 to .3 Carbon Mchy. Steel	1.2 Carbon Tool Steel	Feed Per Revolution, Inches
	100 Ft.	50 Ft.	40 Ft.	30 Ft.	
1	1676	838	670	503	.004
5	1858	925	743	558	.004
10	1975	988	790	593	.004
15	2123	1062	849	637	.0035
20	2374	1187	950	712	.0035
25	2557	1279	1023	767	.003
30	2974	1487	1190	892	.003
35	3475	1738	1390	1043	.0025
40	3900	1950	1560	1170	.002
45	4660	2330	1864	1398	.002
50	5460	2730	2184	1638	.0015
55	7350	3675	2940	2205	.001
60	9554	4777	3822	2866	.0005
65	10914	5457	4366	3274	
70	13642	6821	5457	4093	
75		9095	7276	5457	
80		14147	11318	8488	

High Speed Steel Drills

Diam. of Drill	Brass	Cast Iron	.2 to .3 Carbon Mchy. Steel	1.2 Carbon Tool Steel	Feed Per Revolution, Inches
	200 Ft.	100 Ft.	110 Ft.	60 Ft.	
1	3351	1676	1844	1006	.004
5	3715	1858	2044	1115	.004
10	3950	1975	2173	1185	.004
15	4246	2123	2335	1274	.0035
20	4748	2374	2611	1424	.0035
25	5113	2557	2813	1534	.003
30	5947	2974	3271	1784	.003
35	6949	3475	3823	2085	.0025
40	7800	3900	4290	2340	.002
45	9320	4660	5126	2796	.002
50	10919	5460	6006	3276	.0015
55	14699	7350	8085	4410	.001
60		9554	10509	5732	.0005

Feed to be governed by the material and conditions.
At no time feed so fast that drill will not clear itself.



SUGGESTIONS FOR ORDERING DRILLS

Regular Drills.—Always order by catalogue number.

Special Drills.—Refer to the catalogue number for general style of tool required, giving also the following information:

Special Straight Shank Drills.—Give length over all and length of twist cut. See sketch A.

Special Morse Taper Shank Drills.—Give length over all and length of twist cut. See sketch B. If a special taper shank is required, give diameter at C and D and length. See sketch B. If the shank has a tang give thickness and length. If no tang so state on the order.

We will gladly furnish copies of this page, to any of our customers who desire them for distribution.

It is always understood that when orders for SPECIAL GOODS are accepted they are not subiect to cancellation.

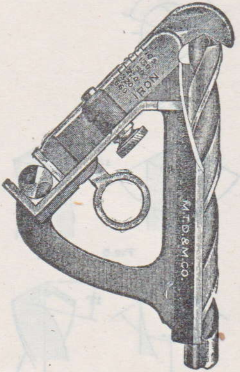
If taper is standard give number.

If taper is special give length B and diameters C and D.

Give thickness and length of tang.

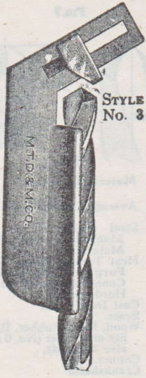
GAUGES FOR GRINDING DRILLS

STYLE No. 1



STYLE No. 2

STYLE No. 3



STYLE No. 4

Grinding of Twist Drills

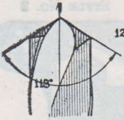


Fig. 1

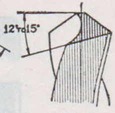


Fig. 2

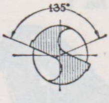


Fig. 3

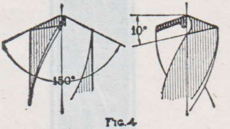


Fig. 4

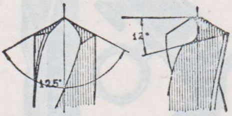


Fig. 5

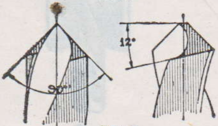


Fig. 6

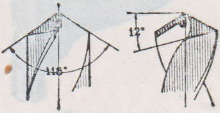


Fig. 7

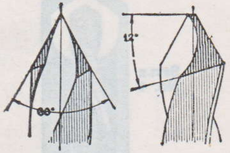


Fig. 8

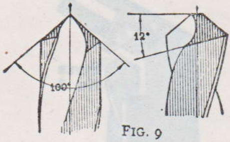


Fig. 9

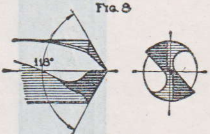


Fig. 10

	Material Used On
Fig. 1, Fig. 2, Fig. 3	Average Class of Work.
Fig. 4	Steel Rails 7% to 13% Manganese and Hard Material.
Fig. 5	Heat Treated Steels, Drop Forgings (Automobile Connecting Rods) Brinell Hardness 250.
Fig. 6	Cast Iron—Soft.
Fig. 7	Brass.
Fig. 8	Wood, Hard Rubber, Bakelite and Fiber (No. 6 may also be used).
Fig. 9	Copper.
Fig. 10	Crankshafts.

Grinding of Twist Drills

Few operations on tools in the shop are more frequently disappointing than the grinding or sharpening of drills.

It is generally understood as requisite to the satisfactory performance of a drill that the cutting edges have a proper and uniform angle with the longitudinal axis of the drill, that they are of exactly equal length with the proper lip clearance or contour of the surface back of the cutting edges and that this clearance must be the same on each lip.

The commercial standard for angle of drill point 118° included angle, (Fig. 1) 12° to 15° lip clearance, (Fig. 2) angle of Chisel Point 125° to 135° (Fig. 3) is best suited for drills engaged in all average classes of work.

To get the maximum efficiency with drills it is necessary to have the points ground correctly. Improper point grinding is costly and efficient results cannot be obtained from a drill unless the grinding of the points is handled in such a way that the proper angle of point, lip clearance and angle of chisel point is obtained.

The form of a drill point exerts a powerful influence upon the rate of production, accuracy of drilled holes and the number of holes which can be drilled between successive grindings.

Drill grinding machines located in tool rooms throughout the plant are steps toward getting the correct point on drills as it is difficult to grind a point by hand that will give the desired results without too much loss of time.

EFFECT OF IMPROPER POINT GRINDING AND COMMON DRILL FAULTS

Cutting lips not of uniform length will drill hole oversize and result in the wearing on margin of one cutting lip.

No lip clearance on drill, inclined to be negative rake, will not cut, causing considerable stress on the machine and burning heel of drill.

Too much lip clearance, leaving insufficient amount of metal behind cutting lips, resulting in chipping and crumbling of cutting edges.

Too fast a periphery speed, causing the breaking down of the outer corners of cutting lips, and considerable wear on the margins of the drill.

Feed too heavy, resulting in the crushing of drill point and oftentimes breaking of drill.

Broken Tangs caused through imperfect fit of taper shank in socket due to dirt, chips or worn-out socket.

Grinding of Twist Drills

(Continued)

DIPPING HIGH SPEED DRILLS IN WATER IS BAD PRACTICE

In up-to-date drilling practice drilling different grades of materials requires at times a modification of the commercial 118° drill point for maximum results.

Hard materials require a blunter point with the more acute angle for softer materials.

We have conducted exhaustive experiments with different angles of points in various grades of materials and are giving this information herewith in hopes that it will be of value to the consumers of drills. Also a list of speeds and feeds for drills used in various materials which were established on a production basis and which will be of value as a standard reference from which to deviate according to conditions. There are many variable factors involved in drilling operations, such as different materials, degrees of hardness, depth of holes, lack of uniformity of materials, lubrication, etc., which make it difficult to establish a list on speeds and feeds that will conform satisfactorily to all conditions.

ANGLE OF POINTS

See page 10

		Point
Steel Rails 7%-13% Manganese and hard materials	Fig. 4	150° included angle 10° lip clearance Slightly flat face of cutting lips.
Heat Treated Steels—Drop Forgings (Automobile Connecting Rods) Brinell Hardness No. 250	Fig. 5	125° included angle 12° lip clearance
Cast Iron—Soft	Fig. 6	90° included angle 12° lip clearance
Brass	Fig. 7	118° included angle 12° lip clearance Slightly flat face of cutting lips.
Wood	Fig. 8	60° included angle 12° lip clearance
Hard Rubber Bakelite Fiber	Figs. 6 & 8	60° and 90° included angle
Copper	Fig. 9	100° included angle 12° lip clearance
Crankshafts	Fig. 10	118° included angle Chisel Point.

THE METRIC SYSTEM.

The metric system is based on the meter which is intended to be and is very nearly, one ten-millionth part of the distance from the equator to the pole. The recorded equivalents of the standard bar in Paris vary by only a few ten-thousandths of an inch from the length authorized by the U. S. Government of 39.37 inches.

Derived from the meter are the unit of volume, the liter, which equals one cubic decimeter, and the gram which is the weight of one cubic centimeter of water. The metric tables are formed by combining the words meter, liter and gram with these prefixes:

Milli = 1/1000 (as "millimeter"); Centi = 1/100; Deci = 1/10;

Deca = 10; Hecto = 100; Kilo = 1000; Myria = 10,000

EQUIVALENTS OF LENGTHS

1 millimeter	=	.03937 inch,	approximately	1/25 inch.
1 centimeter	=	.3937 "	"	25/64 "
1 decimeter	=	3.937 "	"	$3\frac{15}{16}$ "
1 meter	=	39.37 "	"	$39\frac{3}{8}$ "
		or 3.2808 feet, or 1.0936 yards.		
1 kilometer	=	1093.61 yards, or .62137 mile.		
1 inch	=	25.4 millimeters, or 2.54 centimeters.		
1 foot	=	304.8 millimeters, or 30.48 centimeters.		
		3.048 decimeters, or .3048 meter.		
1 yard	=	.9144 meter.		

CONSTANTS FOR CONVERSION.

Millimeters to inches	multiply by	.03937.
Meters to inches	" "	39.37.
Meters to feet	" "	3.2808.
Meters to yards	" "	1.0936.
Inches to millimeters	" "	25.4.
Feet to meters	" "	.3048.
Yards to meters	" "	.9144.

Decimal Equivalents of Drill Sizes

Inch	M. M.	Wire Gauge	Decimals of an Inch	Inch	M. M.	Wire Gauge	Decimals of an Inch	Inch	M. M.	Wire Gauge	Decimals of an Inch
		80	.0135		1.25		.049212		2.5		.098425
		79	.0145		1.3		.051181			39	.0995
1/64			.015625			55	.052			38	.1015
	.4		.015748		1.35		.053149		2.6		.102362
		78	.016			54	.055			37	.104
		77	.018		1.4		.055118		2.7		.106299
	.5		.019685		1.45		.057086			36	.1065
		76	.02		1.5		.059055		2.75		.108267
		75	.021			53	.0595	7/64			.109375
	.55		.021653		1.55		.061023			35	.11
		74	.0225	1/16			.0625		2.8		.110236
	.6		.023622		1.6		.062992			34	.111
		73	.024			52	.0635			33	.113
		72	.025		1.65		.06496		2.9		.114173
	.65		.02559		1.7		.066929			32	.116
		71	.026			51	.067		3		.11811
	.7		.027559		1.75		.068897			31	.12
		70	.028			50	.07		3.1		.122047
		69	.02925		1.8		.070866	1/8			.125
	.75		.029527		1.85		.072834		3.2		.125984
		68	.031			49	.073		3.25		.127952
1/32			.03125		1.9		.074803			30	.1285
	.8		.031496			48	.076		3.3		.129921
		67	.032		1.95		.076771		3.4		.133858
		66	.033	5/64			.078125			29	.136
	.85		.033464			47	.0785		3.5		.137795
		65	.035		2		.07874			28	.1405
	.9		.035433		2.05		.080708	9/64			.140625
		64	.036			46	.081		3.6		.141732
		63	.037			45	.082			27	.144
	.95		.037401		2.1		.082677		3.7		.145669
		62	.038		2.15		.084645			26	.147
		61	.039			44	.086		3.75		.147637
	1		.03937		2.2		.086614			25	.1495
		60	.04		2.25		.088582		3.8		.149606
		59	.041			43	.089			24	.152
	1.05		.041338		2.3		.090551		3.9		.153543
		58	.042		2.35		.092519			23	.154
		57	.043			42	.0935	5/32			.15625
	1.1		.043307	3/32			.09375			22	.157
	1.15		.045275		2.4		.094488		4		.15748
		56	.0465			41	.096			21	.159
3/64			.046875		2.45		.096456			20	.161
	1.2		.047244			40	.098		4.1		.161417

Decimal Equivalents of Drill Sizes

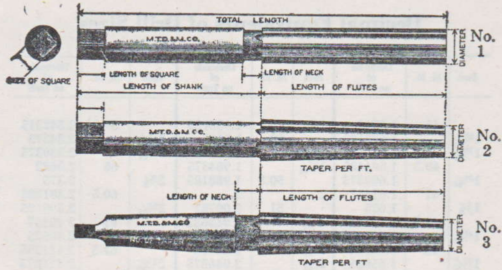
Inch	M. M.	Wire Gauge	Decimals of an Inch	Inch	M. M.	Letter Sizes	Decimals of an Inch	Inch	M. M.	Letter Sizes	Decimals of an Inch
	4.2		.165354		5.9		.232283		8		.31496
		19	.166			A	.234			O	.316
	4.25		.167322	15/64			.234375		8.1		.318897
	4.3		.169291		6		.23622		8.2		.322834
		18	.1695			B	.238			P	.323
11/64			.171875		6.1		.240157		8.25		.324802
		17	.173			C	.242		8.3		.326771
	4.4		.173228		6.2		.244094	21/64			.328125
		16	.177			D	.246		8.4		.330708
	4.5		.177165		6.25		.246062			Q	.332
		15	.18		6.3		.248031		8.5		.334645
	4.6		.181102	1/4		E	.25		8.6		.338582
		14	.182		6.4		.251968			R	.339
		13	.185		6.5		.255905		8.7		.342519
	4.7		.185039			F	.257	11/32			.34375
	4.75		.187007		6.6		.259842		8.75		.344487
3/16			.1875			G	.261		8.8		.346456
	4.8		.188976		6.7		.263779			S	.348
		12	.189	17/64			.265625		8.9		.350393
		11	.191		6.75		.265747		9		.35433
	4.9		.192913			H	.266			T	.358
		10	.1935		6.8		.267716		9.1		.358267
		9	.196		6.9		.271653	23/64			.359375
	5		.19685			I	.272		9.2		.362204
		8	.199		7		.27559		9.25		.364172
	5.1		.200787			J	.277		9.3		.366141
		7	.201		7.1		.279527			U	.368
13/64			.203125			K	.281		9.4		.370078
		6	.204	9/32			.28125		9.5		.374015
	5.2		.204724		7.2		.283464	3/8			.375
		5	.2055		7.25		.285432			V	.377
	5.25		.206692		7.3		.287401		9.6		.377952
	5.3		.208661			L	.29		9.7		.381889
		4	.209		7.4		.291338		9.75		.383857
	5.4		.212598			M	.295		9.8		.385826
		3	.213		7.5		.295275			W	.386
	5.5		.216535	19/64			.296875		9.9		.389763
7/32			.21875		7.6		.299212	25/64			.390625
	5.6		.220472			N	.302		10		.3937
		2	.221		7.7		.303149			X	.397
	5.7		.224409		7.75		.305117			Y	.404
	5.75		.226377		7.8		.307086	13/32			.40625
		1	.228		7.9		.311023			Z	.413
	5.8		.228346	5/16			.3125		10.5		.413385

Decimal Equivalents of Drill Sizes

Inch	M. M.	Decimals of an Inch	Inch	M. M.	Decimals of an Inch	Inch	M. M.	Decimals of an Inch
27/64		.421875		20.5	.807085	1 3/16		1.1875
	11	.43307	13/16		.8125		30.5	1.200785
7/16		.4375		21	.82677	1 13/64		1.203125
	11.5	.452755	53/64		.828125	1 7/32		1.21875
29/64		.453125	27/32		.84375		31	1.22047
15/32		.46875		21.5	.846455	1 15/64		1.234375
	12	.47244	55/64		.859375		31.5	1.240155
31/64		.484375		22	.86614	1 1/4		1.25
	12.5	.492125	7/8		.875		32	1.25984
1/2		.5		22.5	.885825	1 17/64		1.265625
	13	.51181	57/64		.890625		32.5	1.279525
33/64		.515625		23	.90551	1 9/32		1.28125
17/32		.53125	29/32		.90625	1 19/64		1.296875
	13.5	.531495	59/64		.921875		33	1.29921
35/64		.546875		23.5	.925195	1 5/16		1.3125
	14	.55118	15/16		.9375		33.5	1.318895
9/16		.5625		24	.94488	1 21/64		1.328125
	14.5	.570865	61/64		.953125		34	1.33858
37/64		.578125		24.5	.964565	1 11/32		1.34375
	15	.59055	31/32		.96875		34.5	1.358265
19/32		.59375		25	.98425	1 23/64		1.359375
39/64		.609375	63/64		.984375	1 3/8		1.375
	15.5	.610235	1		1.		35	1.37795
5/8		.625		25.5	1.003935	1 25/64		1.390625
	16	.62992	1 1/64		1.015625		35.5	1.397635
41/64		.640625		26	1.02362	1 13/32		1.40625
	16.5	.649605	1 1/32		1.03125		36	1.41732
21/32		.65625		26.5	1.043305	1 27/64		1.421875
	17	.66929	1 3/64		1.046875		36.5	1.437005
43/64		.671875	1 1/16		1.0625	1 7/16		1.4375
11/16		.6875		27	1.06299	1 29/64		1.453125
	17.5	.688975	1 5/64		1.078125		37	1.45669
45/64		.703125		27.5	1.082675	1 15/32		1.46875
	18	.70866	1 3/32		1.09375		37.5	1.476375
23/32		.71875		28	1.10236	1 31/64		1.484375
	18.5	.728345	1 7/64		1.109375		38	1.49606
47/64		.734375		28.5	1.122045	1 1/2		1.5
	19	.74803	1 1/8		1.125	1 33/64		1.515625
3/4		.75	1 9/64		1.140625		38.5	1.515745
49/64		.765625		29	1.14173	1 17/32		1.53125
	19.5	.767715	1 5/32		1.15625		39	1.53543
25/32		.78125		29.5	1.161415	1 35/64		1.546875
	20	.7874	1 11/64		1.171875		39.5	1.555115
51/64		.796875		30	1.1811	1 9/16		1.5625

Decimal Equivalents of Drill Sizes

Inch	M. M.	Decimals of an Inch	Inch	M. M.	Decimals of an Inch	Inch	M. M.	Decimals of an Inch
	40	1.5748	$1\frac{61}{64}$		1.953125		59.5	2.342515
$1\frac{37}{64}$		1.578125		50	1.9685	$2\frac{11}{32}$		2.34375
$1\frac{19}{32}$		1.59375	$1\frac{31}{32}$		1.96875	$2\frac{23}{64}$		2.359375
	40.5	1.594485	$1\frac{63}{64}$		1.984375		60	2.3622
$1\frac{39}{64}$		1.609375		50.5	1.988185	$2\frac{3}{8}$		2.375
	41	1.61417	2		2.		60.5	2.381885
$1\frac{5}{8}$		1.625		51	2.00787	$2\frac{25}{64}$		2.390625
	41.5	1.633855	$2\frac{1}{64}$		2.015625		61	2.40157
$1\frac{41}{64}$		1.640625		51.5	2.027555	$2\frac{13}{32}$		2.40625
	42	1.65354	$2\frac{1}{32}$		2.03125		61.5	2.421255
$1\frac{21}{32}$		1.65625	$2\frac{3}{64}$		2.046875	$2\frac{27}{64}$		2.421875
$1\frac{43}{64}$		1.671875		52	2.04724	$2\frac{7}{16}$		2.4375
	42.5	1.673225	$2\frac{1}{16}$		2.0625		62	2.44094
$1\frac{11}{16}$		1.6875		52.5	2.066925	$2\frac{29}{64}$		2.453125
	43	1.69291	$2\frac{5}{64}$		2.078125		62.5	2.460625
$1\frac{45}{64}$		1.703125		53	2.08661	$2\frac{15}{32}$		2.46875
	43.5	1.712595	$2\frac{3}{32}$		2.09375		63	2.48031
$1\frac{23}{32}$		1.71875		53.5	2.106295	$2\frac{31}{64}$		2.484375
	44	1.73228	$2\frac{7}{64}$		2.109375		63.5	2.499995
$1\frac{47}{64}$		1.734375	$2\frac{1}{8}$		2.125	$2\frac{1}{2}$		2.5
$1\frac{3}{4}$		1.75		54	2.12598	$2\frac{33}{64}$		2.515625
	44.5	1.751965	$2\frac{9}{64}$		2.140625		64	2.51968
$1\frac{49}{64}$		1.765625		54.5	2.145665	$2\frac{17}{32}$		2.53125
	45	1.77165	$2\frac{5}{32}$		2.15625		64.5	2.539365
$1\frac{25}{32}$		1.78125		55	2.16535	$2\frac{35}{64}$		2.546875
	45.5	1.791335	$2\frac{11}{64}$		2.171875		65	2.55905
$1\frac{51}{64}$		1.796875		55.5	2.185035	$2\frac{9}{16}$		2.5625
	46	1.81102	$2\frac{3}{16}$		2.1875	$2\frac{37}{64}$		2.578125
$1\frac{13}{16}$		1.8125	$2\frac{13}{64}$		2.203125		65.5	2.578735
$1\frac{53}{64}$		1.828125		56	2.20472	$2\frac{19}{32}$		2.59375
	46.5	1.830705	$2\frac{7}{32}$		2.21875		66	2.59842
$1\frac{27}{32}$		1.84375		56.5	2.224405	$2\frac{39}{64}$		2.609375
	47	1.85039	$2\frac{15}{64}$		2.234375		66.5	2.618105
$1\frac{55}{64}$		1.859375		57	2.24409	$2\frac{5}{8}$		2.625
	47.5	1.870075	$2\frac{1}{4}$		2.25		67	2.63779
$1\frac{7}{8}$		1.875		57.5	2.263775	$2\frac{41}{64}$		2.640625
	48	1.88976	$2\frac{17}{64}$		2.265625	$2\frac{21}{32}$		2.65625
$1\frac{57}{64}$		1.890625	$2\frac{9}{32}$		2.28125		67.5	2.657475
$1\frac{29}{32}$		1.90625		58	2.28346	$2\frac{43}{64}$		2.671875
	48.5	1.909445	$2\frac{19}{64}$		2.296875		68	2.67716
$1\frac{59}{64}$		1.921875		58.5	2.303145	$2\frac{11}{16}$		2.6875
	49	1.92913	$2\frac{5}{16}$		2.3125		68.5	2.696845
$1\frac{15}{16}$		1.9375		59	2.32283	$2\frac{45}{64}$		2.703125
	49.5	1.948815	$2\frac{21}{64}$		2.328125		69	2.71653



SUGGESTIONS FOR ORDERING REAMERS

REGULAR REAMERS.—Always order by catalog number.

SPECIAL REAMERS.—Refer to the catalog number for general style of tool required, giving also the following information:—

SPECIAL SOLID REAMERS.—Give total length and length of flutes. See sketch No. 1.

SPECIAL TAPER REAMERS.—Give whole length, length of flutes, size at large and small ends of flutes; or size at one end and taper per foot. State whether style No. 2 or No. 3 is required. If style No. 3 give dimensions of taper shank or if Morse Taper is required state number.

SPECIAL SHELL REAMERS.—Give whole length and length of flutes. When these reamers are longer than catalog lengths they are made with Straight Hole and diameter of hole should be given.

We will gladly furnish copies of this page to any of our customers who desire them for distribution.

TO SHARPEN REAMERS

HAND REAMERS, when dull through wear, should be stoned first on the face of the flutes then on top of the flutes. The stone should always be held perfectly flat with the face and clearance that the original shape of the flutes may be preserved.

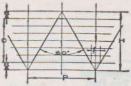
END CUTTING REAMERS should be first ground on centres with a wheel, and then recleared to insure reaming a hole the same size of Reamer.

It is always understood that when orders for SPECIAL GOODS are accepted they are not subject to cancellation.

Basic Thread Dimensions and Tap Drill Sizes

AMERICAN NATIONAL FORM THREADS

(N.C.—N.F.—N.S.)



$$P \text{ (Pitch)} = \frac{1}{\text{No. threads per inch}}$$

$$D \text{ (Depth)} = .649519\ P = \frac{.649519}{n}$$

$$H = .866025\ P$$

$$\frac{H}{8} = .108253\ P$$

$$f \text{ (flat)} = .125\ P = \frac{P}{8}$$

$$n = \text{No. of threads per inch}$$

National Coarse is the former U. S. Standard for sizes ¼ inch and larger, while for sizes under ¼ inch it is the coarse threads of the former A. S. M. E. machine screw sizes.

National Fine is the former S. A. E. Standard for sizes ¼ inch and larger, while for sizes under ¼ inch it is the fine threads of the former A. S. M. E. machine screw sizes.

Nominal Size	Thread Series	Major Diameter, Inches	Pitch Diameter, Inches	Root Diameter, Inches	Commercial Tap Drill to Produce Approx. 75% Full Thread	Decimal Equivalent of Tap Drill
0–80	N. F.	.0600	.0519	.0438	3/64	.0469
1–56	N. S.	.0730	.0614	.0498	54	.0550
64	N. C.	.0730	.0629	.0527	53	.0595
72	N. F.	.0730	.0640	.0550	53	.0595
2–56	N. C.	.0860	.0744	.0628	50	.0700
64	N. F.	.0860	.0759	.0657	50	.0700
3–48	N. C.	.0990	.0855	.0719	47	.0785
56	N. F.	.0990	.0874	.0758	45	.0820
4–32	N. S.	.1120	.0917	.0714	45	.0820
36	N. S.	.1120	.0940	.0759	44	.0860
40	N. C.	.1120	.0958	.0795	43	.0890
48	N. F.	.1120	.0985	.0849	42	.0935
5–36	N. S.	.1250	.1070	.0889	40	.0980
40	N. C.	.1250	.1088	.0925	38	.1015
44	N. F.	.1250	.1102	.0955	37	.1040
6–32	N. C.	.1380	.1177	.0974	36	.1065
36	N. S.	.1380	.1200	.1019	34	.1110
40	N. F	.1380	.1218	.1055	33	.1130
7–32	N. S.	.1510	.1307	.1104	31	.1200

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Basic Thread Dimensions and Tap Drill Sizes

AMERICAN NATIONAL FORM THREADS

(U. S. S.—S. A. E.—A. S. M. E.)

(Continued)

Nominal Size	Thread Series	Major Diameter, Inches	Pitch Diameter, Inches	Root Diameter, Inches	Commercial Tap Drill to Produce Approx. 75% Full Thread	Decimal Equivalent of Tap Drill
8–30	N. S.	.1640	.1423	.1207	30	.1285
32	N. C.	.1640	.1437	.1234	29	.1360
36	N. F.	.1640	.1460	.1279	29	.1360
40	N. S.	.1640	.1478	.1315	28	.1405
9–32	N. S.	.1770	.1567	.1364	26	.1470
10–24	N. C.	.1900	.1629	.1359	25	.1495
28	N. S.	.1900	.1668	.1436	23	.1540
30	N. S.	.1900	.1684	.1467	22	.1570
32	N. F.	.1900	.1697	.1494	21	.1590
12–24	N. C.	.2160	.1889	.1619	16	.1770
28	N. F.	.2160	.1928	.1696	14	.1820
32	N. S.	.2160	.1957	.1754	13	.1850
14–20	N. S.	.2420	.2095	.1770	10	.1935
24	N. S.	.2420	.2149	.1879	7	.2010
16–18	N. S.	.2680	.2319	.1958	3	.2130
18–18	N. S.	.2940	.2579	.2218	B	.2380
1/16–64	N. S.	.0625	.0524	.0422	3/64	.0469
5/64–60	N. S.	.0781	.0673	.0563	1/16	.0625
3/32–48	N. S.	.0938	.0803	.0667	49	.0730
50	N. S.	.0938	.0808	.0678	49	.0730
7/64–48	N. S.	.1094	.0959	.0823	43	.0890
1/8–40	N. S.	.1250	.1088	.0925	38	.1015
9/64–40	N. S.	.1406	.1244	.1081	32	.1160
5/32–32	N. S.	.1563	.1360	.1157	1/8	.1250
36	N. S.	.1563	.1382	.1202	30	.1285
11/64–32	N. S.	.1719	.1516	.1313	9/64	.1406
3/16–24	N. S.	.1875	.1604	.1334	26	.1470
32	N. S.	.1875	.1672	.1469	22	.1570
13/64–24	N. S.	.2031	.1760	.1490	20	.1610
7/32–24	N. S.	.2188	.1917	.1646	16	.1770
32	N. S.	.2188	.1985	.1782	12	.1890
15/64–24	N. S.	.2344	.2073	.1806	10	.1935

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Basic Thread Dimensions and Tap Drill Sizes

AMERICAN NATIONAL FORM THREADS

(U. S. S.—S. A. E.—A. S. M. E.)

(Continued)

Nominal Size	Thread Series	Major Diameter, Inches	Pitch Diameter, Inches	Root Diameter, Inches	Commercial Tap Drill to Produce Approx. 75% Full Thread	Decimal Equivalent of Tap Drill
¼–20	N. C.	2500	.2175	.1850	7	.2010
24	N. S.	.2500	.2229	.1959	4	.2090
27	N. S.	.2500	.2260	.2019	3	.2130
28	N. F.	.2500	.2268	.2036	3	.2130
32	N. S.	.2500	.2297	.2094	7/32	.2188
5/16–18	N. C.	.3125	.2764	.2403	F	.2570
20	N. S.	.3125	.2800	.2476	17/64	.2656
24	N. F.	.3125	.2854	.2584	I	.2720
27	N. S.	.3125	.2884	.2644	J	.2770
32	N. S.	.3125	.2922	.2719	9/32	.2812
⅜–16	N. C.	.3750	.3344	.2938	5/16	.3125
20	N. S.	.3750	.3425	.3100	21/64	.3281
24	N. F.	.3750	.3479	.3209	Q	.3320
27	N. S.	.3750	.3509	.3269	R	.3390
7/16–14	N. C.	.4375	.3911	.3447	U	.3680
20	N. F.	.4375	.4050	.3726	25/64	.3906
24	N. S.	.4375	.4104	.3834	X	.3970
27	N. S.	.4375	.4134	.3894	Y	.4040
½–12	N. S.	.5000	.4459	.3918	27/64	.4219
13	N. C.	.5000	.4500	.4001	27/64	.4219
20	N. F.	5000	.4675	.4351	29/64	.4531
24	N. S.	.5000	.4729	.4459	29/64	.4531
27	N. S.	5000	.4759	.4519	15/32	.4687
9/16–12	N. C.	5625	.5084	.4542	31/64	.4844
18	N. F.	5625	.5264	.4903	33/64	.5156
27	N. S.	5625	.5384	5144	17/32	.5312
⅝–11	N. C.	.6250	.5660	.5069	17/32	.5312
12	N. S.	6250	.5709	.5168	35/64	.5469
18	N. F.	6250	.5889	.5528	37/64	.5781
27	N. S.	.6250	.6009	.5769	19/32	.5937
11/16–11	N. S.	.6875	.6285	.5694	19/32	.5937
16	N. S.	6875	.6469	6063	⅝	.6250
¾–10	N. C.	7500	6850	.6201	21/32	.6562
12	N. S.	7500	6959	.6418	43/64	.6719
16	N. F.	.7500	.7094	.6688	11/16	.6875
27	N. S.	.7500	.7259	.7019	23/32	.7187

(Continued on next page)

Basic Thread Dimensions and Tap Drill Sizes

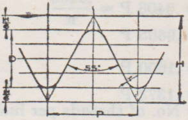
AMERICAN NATIONAL FORM THREADS

(U. S. S.—S. A. E.—A. S. M. E.)

(Concluded)

Nominal Size	Thread Series	Major Diameter, Inches	Pitch Diameter, Inches	Root Diameter, Inches	Commercial Tap Drill to Produce Approx. 75% Full Thread	Decimal Equivalent of Tap Drill
13/16–10	N. S.	.8125	.7476	.6826	23/32	.7187
7/8–9	N. C.	.8750	.8028	.7307	49/64	.7656
12	N. S.	.8750	.8209	.7668	51/64	.7969
14	N. F.	.8750	.8286	.7822	13/16	.8125
18	N. S.	.8750	.8389	.8028	53/64	.8281
27	N. S.	.8750	.8509	.8269	27/32	.8437
15/16–9	N. S.	.9375	.8654	.7932	53/64	.8281
1 – 8	N. C.	1.0000	.9188	.8376	7/8	.8750
12	N. S.	1.0000	.9459	.8918	59/64	.9219
14	N. F.	1.0000	.9536	.9072	15/16	.9375
27	N. S.	1.0000	.9759	.9519	31/32	.9687
1 1/8 – 7	N. C.	1.1250	1.0322	.9394	63/64	.9844
12	N. F.	1.1250	1.0709	1.0168	1 3/64	1.0469
1 1/4 – 7	N. C.	1.2500	1.1572	1.0644	1 7/64	1.1094
12	N. F.	1.2500	1.1959	1.1418	1 11/64	1.1719
1 3/8 – 6	N. C.	1.3750	1.2667	1.1585	1 7/32	1.2187
12	N. F.	1.3750	1.3209	1.2668	1 19/64	1.2969
1 1/2 – 6	N. C.	1.5000	1.3917	1.2835	1 11/32	1.3437
12	N. F.	1.5000	1.4459	1.3918	1 27/64	1.4219
1 5/8 – 5 1/2	N. S.	1.6250	1.5069	1.3888	1 29/64	1.4531
1 3/4 – 5	N. C.	1.7500	1.6201	1.4902	1 9/16	1.5625
1 7/8 – 5	N. S.	1.8750	1.7451	1.6152	1 11/16	1.6875
2 – 4 1/2	N. C.	2.0000	1.8557	1.7113	1 25/32	1.7812
2 1/8 – 4 1/2	N. S.	2.1250	1.9807	1.8363	1 29/32	1.9062
2 1/4 – 4 1/2	N. C.	2.2500	2.1057	1.9613	2 1/32	2.0312
2 3/8 – 4	N. S.	2.3750	2.2126	2.0502	2 1/8	2.1250
2 1/2 – 4	N. C.	2.5000	2.3376	2.1752	2 1/4	2.2500
2 3/4 – 4	N. C.	2.7500	2.5876	2.4252	2 1/2	2.5000
3 – 4	N. C.	3.0000	2.8376	2.6752	2 3/4	2.7500

BRITISH STANDARD WHITWORTH THREAD



$$P \text{ (Pitch)} = \frac{1}{\text{No. threads per inch}}$$

$$D \text{ (Depth)} = .6403\,P = \frac{.6403}{n}$$

$$H = .9605\,P$$

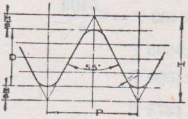
$$\frac{H}{6} = .1600\,P$$

$$r = .1373\,P$$

$$n = \text{No. of threads per inch}$$

Nominal Diameter of Screw	No. of Threads Per Inch	Standard Single Depth of Thread	Effective Diameter (Pitch Diameter)	Commercial Tap Drill to Produce 75% Full Thread
1/4	20	.0320	.2180	13/64
5/16	18	.0356	.2769	F
3/8	16	.0400	.3350	O
7/16	14	.0457	.3918	U
1/2	12	.0534	.4466	27/64
9/16	12	.0534	.5091	31/64
5/8	11	.0582	.5668	35/64
3/4	10	.0640	.6860	21/32
7/8	9	.0711	.8039	49/64
1	8	.0800	.9200	7/8
1 1/8	7	.0915	1.0335	1
1 1/4	7	.0915	1.1585	1 7/64
1 1/2	6	.1067	1.3933	1 11/32
1 3/4	5	.1281	1.6219	1 9/16
2	4 1/2	.1423	1.8577	1 25/32
2 1/4	4	.1601	2.0899	2
2 1/2	4	.1601	2.3399	2 1/4

BRITISH STANDARD FINE THREAD



$$P\ (\text{Pitch}) = \frac{1}{\text{No. threads per inch}}$$

$$D\ (\text{Depth}) = .6403\ P = \frac{.6403}{n}$$

$$H = .9605\ P$$

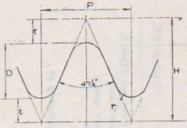
$$\frac{H}{6} = .1600\ P$$

$$r = .1373\ P$$

$$n = \text{No. of threads per inch}$$

Nominal Diameter of Screw	No. of Threads Per Inch	Standard Single Depth of Thread	Effective Diameter (Pitch Diameter)	Commercial Tap Drill to Produce 75% Full Thread
1/4	26	.0246	.2254	No. 3
9/32	26	.0246	.2566	D
5/16	22	.0291	.2834	M
3/8	20	.0320	.3430	21/64
7/16	18	.0356	.4019	W
1/2	16	.0400	.4600	7/16
9/16	16	.0400	.5225	1/2
5/8	14	.0457	.5793	9/16
11/16	14	.0457	.6418	5/8
3/4	12	.0534	.6966	43/64
13/16	12	.0534	.7591	47/64
7/8	11	.0582	.8168	25/32
1	10	.0640	.9360	29/32
1 1/8	9	.0711	1.0539	1 1/64
1 1/4	9	.0711	1.1789	1 9/64
1 3/8	8	.0800	1.2950	1 17/64
1 1/2	8	.0800	1.4200	1 25/64
1 3/4	7	.0915	1.6585	1 39/64
2	7	.0915	1.9085	1 55/64

BRITISH ASSOCIATION SCREW THREAD



$$P \text{ (Pitch)} = \frac{1}{\text{No. threads per inch}}$$

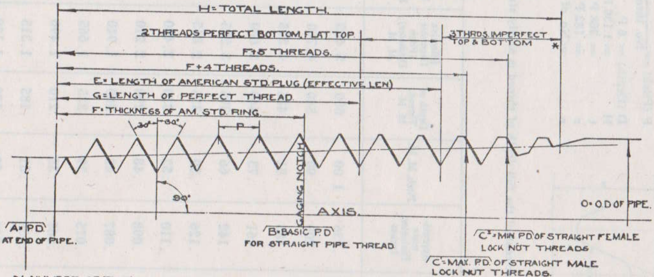
D (Depth) $= .6\ P$
$H = 1.136\ P$
$t = .268\ P$
$r = .182\ P$
$n =$ No. of threads per inch

Seventy-five per cent of the full depth of thread is amply strong for all ordinary work.

Number	Diameter M. M. (Major Diameter)	Approximate Diameter, Inches	Pitch, M. M.	Depth of Thread, M. M.	Effective Diameter (Pitch Diameter), M. M.	Core Diameter (Minor Diameter), M. M.	Drill Sizes Nearest Commercial Drill to Produce 75% Depth of Thread
0	6.0	.236	1.00	.600	5.400	4.80	No. 7
1	5.3	.209	.90	.540	4.760	4.22	16
2	4.7	.185	.81	.485	4.215	3.73	22
3	4.1	.161	.73	.440	3.660	3.22	29
4	3.6	.142	.66	.395	3.205	2.81	31
5	3.2	.126	.59	.355	2.845	2.49	37
6	2.8	.110	.53	.320	2.480	2.16	43
7	2.5	.098	.48	.290	2.210	1.92	46
8	2.2	.087	.43	.260	1.940	1.68	48
9	1.9	.075	.39	.235	1.665	1.43	1/16 in.
10	1.7	.067	.35	.210	1.490	1.28	54
11	1.5	.059	.31	.185	1.315	1.13	56
12	1.3	.051	.28	.170	1.130	.96	59
14	1.0	.039	.23	.140	.860	.72	65

American National Pipe Threads

WITH LOCKNUT THREADS AND BASIC STRAIGHT PIPE SIZES



N = NUMBER OF THREADS PER INCH. DEPTH OF PIPE THREADS = .8P

$\frac{3}{4}$ TAPER PER FOOT ON DIAMETER. DEPTH OF GAGE THREADS = .6660P

*3 OR 4 IMPERFECT THREADS MAY BE USED. WHEN USING 4 IMPERFECT THREADS, ADD ONE TO COLUMN H.

American National Pipe Threads

(Concluded)

WITH LOCKNUT THREADS AND BASIC STRAIGHT PIPE SIZES

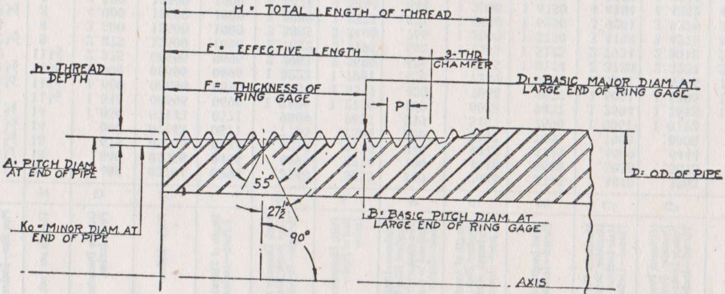
Pipe Size—Inches	Threads per Inch	Outside Diameter Pipe—Inches	Pitch—Inches	Depth of Thread .8 Pitch—Inches	Pitch Diameter at Gage Notch Basic Straight—Inches	Pitch Diameter at End of Pipe—Inches	Thickness of American Standard Ring Gage (also distance from small end to gaging notch)—Inches	Length of American Standard Plug (effective length of thread on pipe)—Inches	Total Length of Thread—Inches	Maximum Pitch Diameter, Straight Male Locknut Thread—Inches	Minimum Pitch Diameter, Straight Female Locknut Thread—Inches	*Tap Drill Size
	N	D	P		B	A	F	E	H	C^1	C^2	
1/8	27	.405	.03704	.0296	.3748	.3635	.180	.2638	.3749	.3840	.3863	R
1/4	18	.540	.05556	.0444	.4899	.4774	.200	.4018	.5685	.5038	.5073	7/16
3/8	18	.675	.05556	.0444	.6270	.6120	.240	.4078	.5745	.6409	.6444	37/64
1/2	14	.840	.07143	.0571	.7784	.7584	.320	.5337	.7480	.7963	.8008	23/32
3/4	14	1.050	.07143	.0571	.9889	.9677	.339	.5457	.7600	1.0067	1.0112	59/64
1	11½	1.315	.08696	.0696	1.2386	1.2136	.400	.6828	.9437	1.2604	1.2658	1 5/32
1¼	11½	1.660	.08696	.0696	1.5834	1.5571	.420	.7068	.9677	1.6051	1.6106	1½
1½	11½	1.900	.08696	.0696	1.8223	1.7961	.420	.7235	.9844	1.8441	1.8495	1 47/64
2	11½	2.375	.08696	.0696	2.2963	2.2690	.436	.7565	1.0174	2.3180	2.3234	2 7/32
2½	8	2.875	.12500	.1000	2.7622	2.7195	.682	1.1375	1.5125	2.7934	2.8012	2⅝
3	8	3.500	.12500	.1000	3.3885	3.3406	.766	1.2000	1.5750	3.4198	3.4276	3¼
3½	8	4.000	.12500	.1000	3.8888	3.8375	.821	1.2500	1.6250	3.9201	3.9279	3¾
4	8	4.500	.12500	.1000	4.3871	4.3344	.844	1.3000	1.6750	4.4184	4.4262	4¼
4½	8	5.000	.12500	.1000	4.8859	4.8313	.875	1.3500	1.7250	4.9172	4.9250	....
5	8	5.563	.12500	.1000	5.4493	5.3907	.937	1.4063	1.7813	5.4806	5.4884	....
6	8	6.625	.12500	.1000	6.5060	6.4461	.958	1.5125	1.8875	6.5372	6.5450	....
8	8	8.625	.12500	.1000	8.5000	8.4336	1.063	1.7125	2.0875	8.5313	8.5391	....
10	8	10.750	.12500	.1000	10.6209	10.5453	1.210	1.9250	2.3000	10.6522	10.6600	....
12	8	12.750	.12500	.1000	12.6178	12.5328	1.360	2.1250	2.5000	12.6491	12.6569	....

*Tap drill sizes given permit of direct tapping without reaming the hole.

Basic Thread Dimensions and Tap Drill Sizes

British Standard Pipe Thread

Whitworth Form **(American Tap Manufacturers' Practice)**



Formula:
- N = number of threads per inch
- $\frac{3}{4}''$ taper per foot on diameter
- P = pitch
- Depth of pipe thread = .0640327 P.

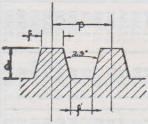
Note — A change in length of chamfer changes "H."

Basic Thread Dimensions and Tap Drill Sizes
British Standard Pipe Thread
Whitworth Form **(American Tap Manufacturers' Practice)**
(Concluded)

Pipe Size Nominal — Inches	Threads per Inch	Outside Diameter of Pipe (Mean) — Inches	Pitch Inches	Depth of Thread .064032 P — Inches	Basic Major Diam. at Large End of Ring Gage — Inches	Basic Pitch Diam. at Large End of Ring Gage — Inches	Pitch Diam. at End of Pipe — Inches	Minor Diam at End of Pipe — Inches	Thickness of Ring Gage = Normal Engagement by Hand — Inches	Effective Length of Thread (Basic) — Inches	Total Length of Thread — Inches	Plus or Minus Tolerance on Length of Engagement		Tap Drill Sizes — Inches
												External Thread — Inches	Internal Thread — Inches	
	N	D	P	h	D¹	B	A	Ko	F	E	H			
1/8	28	.400	.03571	.0229	.383	.3601	.3503	.3274	.1563	.2545	.362	.0357	.0446	21/64
1/4	19	.538	.05263	.0337	.518	.4843	.4695	.4358	.2367	.3814	.539	.0526	.0658	29/64
3/8	19	.676	.05263	.0337	.656	.6223	.6067	.5730	.2500	.3947	.553	.0526	.0658	37/64
1/2	14	.847	.07143	.0457	.825	.7793	.7592	.7135	.3214	.5178	.732	.0714	.0893	23/32
3/4	14	1.063	.07143	.0457	1.041	.9953	.9719	.9262	.3750	.5714	.786	.0714	.0893	59/64
1	11	1.336	.09091	.0582	1.309	1.2508	1.2253	1.1671	.4091	.6591	.932	.0909	.1136	1 11/64
1 1/4	11	1.677	.09091	.0582	1.650	1.5918	1.5605	1.5023	.5000	.7500	1.023	.0909	.1136	1 1/2
1 1/2	11	1.909	.09091	.0582	1.882	1.8238	1.7925	1.7343	.5000	.7500	1.023	.0909	.1136	1 3/4
2	11	2.381	.09091	.0582	2.347	2.2888	2.2497	2.1915	.6250	.9204	1.193	.0909	.1136	2 7/32
2 1/2	11	2.996	.09091	.0582	2.960	2.9018	2.8588	2.8006	.6875	1.0511	1.324	.1364	.1364	2 13/16
3	11	3.499	.09091	.0582	3.460	3.4018	3.3510	3.2928	.8125	1.1761	1.449	.1364	.1364	3 5/16
3 1/2	11	3.991	.09091	.0582	3.950	3.8918	3.8371	3.7789	.8750	1.2386	1.511	.1364	.1364	3 13/16
4	11	4.494	.09091	.0582	4.450	4.3918	4.3293	4.2711	1.0000	1.4091	1.682	.1364	.1364	...
5	11	5.498	.09091	.0582	5.450	5.3918	5.3215	5.2633	1.1250	1.5795	1.852	.1364	.1364	...
6	11	6.501	.09091	.0582	6.450	6.3918	6.3215	6.2633	1.1250	1.5795	1.852	.1364	.1364	...
7	10	7.519	.10000	.0640	7.450	7.3860	7.3001	7.2361	1.3750	1.9250	2.225	.2000	.2000	...
8	10	8.524	.10000	.0640	8.450	8.3860	8.2922	8.2282	1.5000	2.0500	2.3500	.2000	.2000	...
9	10	9.529	.10000	.0640	9.450	9.3860	9.2922	9.2282	1.5000	2.0500	2.3500	.2000	.2000	...
10	10	10.534	.10000	.0640	10.450	10.3860	10.2844	10.2204	1.6250	2.1750	2.4750	.2000	.2000	...
11	8	11.540	.12500	.0800	11.450	11.3700	11.2684	11.1884	1.6250	2.3125	2.688	.2500	.2500	...
12	8	12.545	.12500	.0800	12.450	12.3700	12.2684	12.1884	1.6250	2.3125	2.688	.2500	.2500	...

Basic Thread Dimensions

AMERICAN NATIONAL ACME SCREW THREAD



SYMBOLS

d = Depth of thread with clearance
D = { Tap drill / Minor diameter of nut
f = Width of flat at top of thread
f' = Width of flat at bottom of space
n = Number of threads per inch
p = Pitch of thread
R = Minor diameter of screw
S = Major diameter of screw
T = Major diameter of tap

Formulae

(Approximate)

$p = \frac{1}{n}$ $\qquad f = \frac{.3707}{n}$

$D = S\text{-}p$ $\qquad R = S\text{-}2d$

For 10 or less threads per inch

$d = \frac{p}{2}$ plus .010

$f' = \frac{.3707}{n}$ minus .0052

T = S plus .020

For more than 10 threads per inch

$d = \frac{p}{2}$ plus .005

$f' = \frac{.3707}{n}$ minus .0026

T = S plus .010

TABLE OF THREAD PARTS

Pitch (p)	Threads per Inch (n)	Depth of Thread with Clearance (d)	Flat at Top of Thread (f)	Flat at Bottom of Space (f')	Space at Top of Thread	Thickness at Root of Thread
1	1	.5100	.3707	.3655	.6293	.6345
3/4	1-1/3	.3850	.2780	.2728	.4720	.4772
1/2	2	.2600	.1854	.1802	.3146	.3198
1/2	3	.1767	.1236	.1184	.2097	.2149
1/4	4	.1350	.0927	.0875	.1573	.1625
1/5	5	.1100	.0741	.0689	.1259	.1311
1/6	6	.0933	.0618	.0566	.1049	.1101
1/7	7	.0814	.0530	.0478	.0899	.0951
1/8	8	.0725	.0463	.0411	.0787	.0839
1/9	9	.0655	.0412	.0360	.0699	.0751
1/10	10	.0600	.0371	.0319	.0629	.0681
1/12	12	.0467	.0309	.0283	.0524	.0550
1/14	14	.0407	.0265	.0239	.0449	.0475
1/16	16	.0363	.0232	.0206	.0393	.0419

(*Concluded on following page*)

Basic Thread Dimensions

AMERICAN NATIONAL ACME SCREW THREAD

(Concluded)

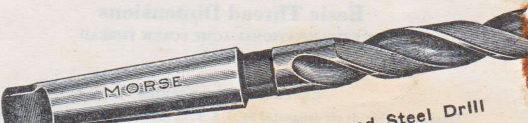
GENERAL PURPOSE SERIES

These Acme threads are designated by N. S. T. C. as standard. There are a number of reasons which make it both economical and advantageous to adopt Acme screws from this table. For example, all items ½" and larger have pitches which permit the use of evenly graduated dials on lead screws. Helix angles are 5° or less, making for ease of manufacture. Threads are strong in proportion to diameters.

If a greater lead is required on a given diameter than the thread recommended it is advisable to use a multiple thread of that lead rather than a single thread of that pitch.

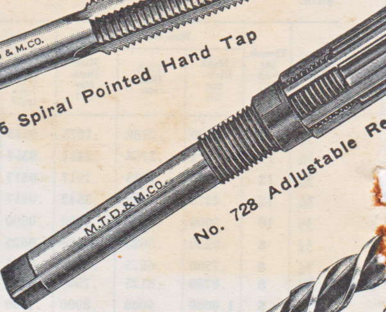
Size Inches	Threads per Inch (N)	Basic Dimensions			Thread Data			
		Major Diameter (S)	Pitch Diameter	Minor Diameter (D)	Thickness at Pitch Line (p/2)	Depth Thread with Clearance (d)	Basic Width of Flat (f)	Helix Angle at Pitch Diam.
¼	16	.2500	.2188	.1875	.0313	.0363	.0232	5° 12′
5/16	14	.3125	.2768	.2411	.0357	.0407	.0265	4° 42′
⅜	12	.3750	.3333	.2917	.0417	.0467	.0309	4° 33′
7/16	12	.4375	.3958	.3542	.0417	.0467	.0309	3° 50′
½	10	.5000	.4500	.4000	.0500	.0600	.0371	4° 3′
⅝	8	.6250	.5625	.5000	.0625	.0725	.0463	4° 3′
¾	8	.7500	.6875	.6250	.0625	.0725	.0463	3° 19′
⅞	8	.8750	.8125	.7500	.0625	.0725	.0463	2° 48′
1	5	1.0000	.9000	.8000	.1000	.1100	.0741	4° 3′
1⅛	5	1.1250	1.0250	.9250	.1000	.1100	.0741	3° 33′
1¼	5	1.2500	1.1500	1.0500	.1000	.1100	.0741	3° 10′
1⅜	5	1.3750	1.2750	1.1750	.1000	.1100	.0741	2° 52′
1½	4	1.5000	1.3750	1.2500	.1250	.1350	.0927	3° 19′
1¾	4	1.7500	1.6250	1.5000	.1250	.1350	.0927	2° 48′
2	4	2.0000	1.8750	1.7500	.1250	.1350	.0927	2° 26′
2½	2	2.5000	2.2500	2.0000	.2500	.2600	.1854	4° 3′
3	2	3.0000	2.7500	2.5000	.2500	.2600	.1854	3° 19′
4	2	4.0000	3.7500	3.5000	.2500	.2600	.1854	2° 26′
5	2	5.0000	4.7500	4.5000	.2500	.2600	.1854	1° 55′

UP-TO-DATE

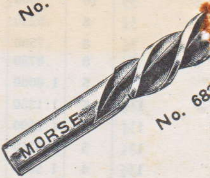


No. 1302 High Speed Steel Drill

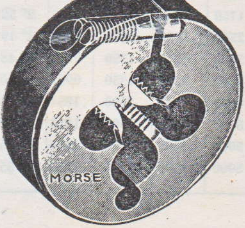
No. 1045 Spiral Pointed Hand Tap



No. 728 Adjustable Re

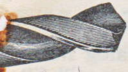


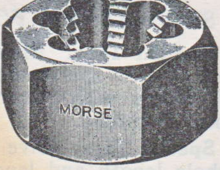
No. 68



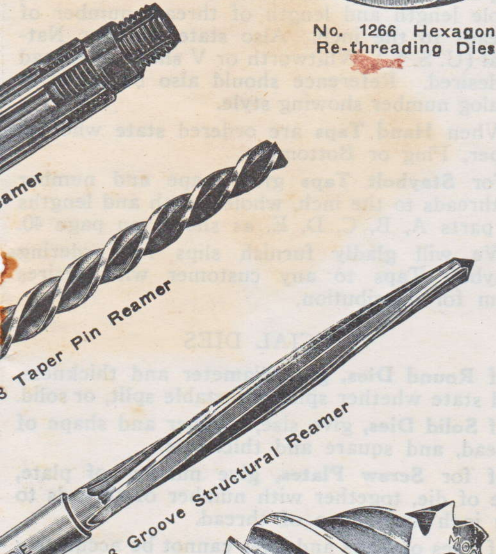
No. 1184 Round Adjustable Die

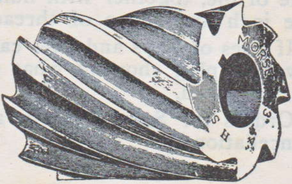
MORSE TOOLS





No. 1266 Hexagon Re-threading Dies





No. 1802 Coarse Tooth Plain Milling Cutter

SUGGESTIONS FOR ORDERING TAPS

Regular Taps. Always order by catalog number. Unless specified to the contrary we will fill all orders with American National (U. S. S.) form of thread.

Special Taps. Give exact diameter of thread, whole length and length of thread, number of threads to the inch. Also state whether National (U. S. S.), Whitworth or V shape of thread is desired. Reference should also be made to catalog number showing style.

When **Hand Taps** are ordered state whether Taper, Plug or Bottoming.

For **Staybolt Taps** give shape and number of threads to the inch, whole length and lengths of parts A, B, C, D, E, as shown on page 40.

We will gladly furnish slips for ordering Staybolt Taps to any customer who desires them for distribution.

SPECIAL DIES

If **Round Dies,** give diameter and thickness, and state whether split, adjustable split, or solid.

If **Solid Dies,** give size, number and shape of thread, and square and thickness.

If for **Screw Plates,** give number of plate, size of die, together with number of threads to the inch and shape of thread.

If sizes of Taps and Dies cannot be accurately given, a plug showing what is required should be furnished.

Orders for **Special Goods** are not subject to cancellation.

TABLE FOR USE WITH

SCREW THREAD MICROMETER CALIPER.

READING OF CALIPER.

For N.C. (U.S.S.) Threads, $D - \frac{6495}{P}$ For "V" THREADS, $D - \frac{.866}{P}$.

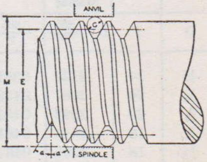
N. C. (U.S.S.) Threads				"V" THREADS			
Diameter	Pitch	Caliper Reading		Diameter	Pitch	Caliper Reading	
D	P	$D - \frac{.6495}{P}$	$\frac{6495}{P}$	D	P	$D - \frac{.866}{P}$	$\frac{.866}{P}$
1/4	20	2176	0324	1/4	24	.2139	0361
5/16	18	2765	0360	1/4	20	.2067	0433
3/8	16	.3344	0406	5/16	20	.2692	.0433
7/16	14	.3911	0464	5/16	18	.2644	0481
1/2	13	.4501	0499	3/8	18	.3269	0481
9/16	12	5084	0541	3/8	16	.3209	0541
5/8	11	566	0590	7/16	16	.3834	.0541
3/4	10	6851	0649	7/16	14	3756	0619
7/8	9	8029	0721	1/2	14	.4381	.0619
1	8	9188	0812	1/2	13	.4334	0666
1 1/8	7	1 0322	0928	1/2	12	.4278	0722
1 1/4	7	1 1572	0928	9/16	14	.5006	0619
1 3/8	6	1 2668	1082	9/16	12	.4903	0722
1 1/2	6	1.3918	1082	5/8	11	.5463	0787
1 5/8	5 1/2	1 507	1180	5/8	10	.5384	.0866
1 3/4	5	1 6201	1299	11/16	10	.6009	0866
1 7/8	5	1 7451	1299	3/4	10	.6634	0866
2	4 1/2	1 8557	1443	7/8	9	.7788	.0962
2 1/2	4	2 3376	1624	1	8	.8918	.1082
3	3 1/2	2 8145	1855	1 1/8	8	1.0168	.1082
3 1/2	3 1/4	3 3002	1998	1 1/4	7	1.1263	1237
4	3	3 7835	2165	1 1/2	6	1.3557	.1443

The right hand column gives the number to be subtracted from the diameter to obtain the caliper reading

The figures in above table apply only to screws made accurately to standard size.

Three-Wire Measurement of Pitch Diameter of Screw Threads

The three-wire method of measurement is recommended for the determination of pitch diameter of all American National screw threads. In this method, the general formula for determining pitch diameter of threads in which the slight effect of helix angle is not taken into account (all NC and NF standard threads) is:



$$E = M + \frac{\cot a}{2n} - G\,(1 + \operatorname{cosec} a)$$

in which
E = pitch diameter
M = measurement over wires
a = one-half included angle of thread
n = number of threads per inch
G = diameter of wires

For all 60° threads with a helix angle less than six degrees, this formula simplifies to:

$$E = M + \frac{0.86603}{n} - 3G$$

When the helix angle is six degrees or more, the helix must be taken into account and the formua is:

$$E = M + \frac{\cot a}{2n} - G\left(1 + \operatorname{cosec} a + \frac{S^2}{2} \cos a \cot a\right)$$

in which:

$$S = \text{tangent of helix angle} = \frac{L}{3.1416E}; \text{ where } L = \text{lead}$$

For the best results, an accurate measuring instrument with proper measuring pressures is required. Threads 20 per inch and coarser are calibrated at 2¼ to 2½ lbs., measuring pressure. Threads finer than 20 per inch are calibrated at 14 to 16 ozs. measuring pressure.

Wires must be uniformly hard. They should be within .00002″ for roundness and straightness. All three wires in a set should be the same size within .00003″ and should not vary from the "best size" by more than .0001″. All wires should be calibrated when crossed over a .750 roll and the measuring pressure should be exactly the same as the measuring pressure used when checking the screw thread.

(Concluded on following page)

Three-Wire Measurement of Pitch Diameter of Screw Threads

(Concluded)

"Best size" wires (as recommended by the Bureau of Standards) for standard 60° threads are listed in the following table.

Recommended Wire Sizes

for checking 60° threads, including American National Straight Threads, American National Pipe Threads, etc.

Threads per Inch	*Best Wire Size	Threads per Inch	*Best Wire Size
80	.00722	14	.04124
72	.00802	13	.04441
64	.00902	12	.04811
56	.01031	11½	.05020
48	.01203	11	.05249
44	.01312	10	.05774
40	.01443	9	.06415
36	.01604	8	.07217
32	.01804	7	.08248
30	.01924	6	.09623
28	.02062	5	.11547
27	.02138	4½	.12830
24	.02406	4	.14434
20	.02887	3½	.16496
18	.03208	3¼	.17765
16	.03608	3	.19245

* It is possible to use other than the recommended size wires if "best size" wires are not available but the resulting measurement is not usually as accurate.

The National Screw-thread Commission have recommended the name "American National Standard," in place of "United States Standard," using the letters N.C. as meaning "National Coarse" and N.F. as "National Fine" in place of the former method of marking, — U.S.S. and S.A.E. The term "National Special" (N.S.) will be used for other pitches of this same shape thread.

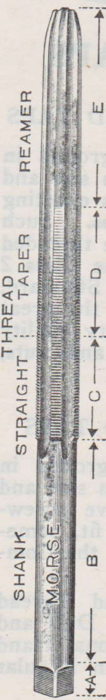
So wherever we use these terms please bear in mind that—

N.C. is the same as U.S.S.

N.F. is the same as S.A.E.

N.S. is the same as "U.S. Form" or "U.S.S. Shape."

STAYBOLT TAPS



All Taps have 12 threads to the inch and can be furnished in either American National, Whitworth or V form of thread. American National form of thread furnished unless otherwise specified.

Interrupted Thread Staybolt Taps can be furnished if desired. Prices on application.

Staybolt Taps 20 inches, 24 inches and 27 inches long in sizes listed below have the following proportions.

LENGTH DIMENSIONS — INCHES

Total	A Square	B Round Shank	C Stra'ht Thread	D Taper Thread	E Reamer
20	1	6	1½	6	5½
24	1	8	2	6	7
27	1	10	2	6½	7½

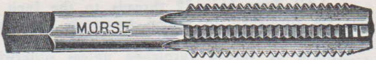
Taps shorter than 20 inches will be charged as if 20 inches long and fractions of an inch in length will be charged as a full extra inch, but are considered special.

Sizes and dimensions not listed are special. In ordering, state diameter, pitch, and form of thread, also lengths of parts A, B, C, D and E.

Left Hand Taps are special.

AVERAGE LENGTHS

Whole Length of Tap, Inches	Length, Inches A	B	C	D	E
12	1	3	2	3	3
14	1	4	2	3½	3½
16	1	4½	2	4	4½
18	1	5	2	5	5
21	1	6	2	5½	6½
24	1	8	2	6	7
27	1	9	3	6½	7½
30	1	10	4	6½	8½
33	1	11	4	6½	10½
36	1	12	4	6½	12½
39	1	13	5	7½	12½
42	1	14	5	8½	13½
48	1	16	6	10	15
54	1	18	6	11	18



GROUND THREAD TAPS

COMMERCIAL GROUND THREAD TAPS

Made of High Speed Steel and ground in the thread forms to give exactness in size and lead within tolerances that are not as exacting as in **Precision Ground Thread Taps.** Such taps are designated in size to produce threaded holes to tolerances comparable to the Class 2 National Screw Thread Commission Standard, which is the recognized standard for the great bulk of screw-thread work of ordinary quality of finished and semi-finished bolts and nuts, machine screws, etc.

PRECISION GROUND THREAD TAPS

Made of High Speed Steel and ground in the thread forms to give exactness in size and lead within tolerances that will give screw-thread work requiring a fine snug fit, somewhat closer than the fit produced by the Commercial Ground Thread Taps.

Commercial and Precision Ground Thread Taps as made by the Morse Twist Drill and Machine Co. are furnished in fractional Hand Tap and Machine Screw sizes and in Regular Fluted and Spiral Pointed styles.

SUGGESTIONS FOR ORDERING CUTTERS

REGULAR CUTTERS.—Always order by catalogue number giving diameter, face and size of hole.

SPECIAL MILLING CUTTERS.—Give diameter, face, size of hole and keyway and refer to catalogue number for style. When End Mills, Angular Mills, Facing Mills and T Slot Cutters are desired, be particular to state whether RIGHT OR LEFT HAND.

FORMED CUTTERS.—Sketches showing form and all dimensions, or template showing form together with all dimensions should be furnished when ordering Formed Cutters. Also state whether Cutter is "coming" or "going" at the bottom. Formed Cutters are adopted for work where uniformity is required, and are sharpened by grinding the faces of the teeth.

GEAR CUTTERS.—Give number of cutter and diametral pitch when ordering. Diametral pitch means the number of teeth to the inch in diameter in pitch circle of any gear. These cutters are sharpened by grinding the faces of the teeth.

To get best results be sure Cutters are KEPT SHARP.

It is always understood that when orders for SPECIAL GOODS are accepted they are not subject to cancellation.

CUTTER CLEARANCE

Correct clearance on cutters is important and should always be considered when a cutter is being sharpened. The cutting edge only should come in contact with the work and sufficient stock should be removed back from the cutting edge so that there is no scraping or dragging action.

For the greatest production,—
For the smoothest surfaces,—
For the least power,—
For the longest life,—
For the highest economy,—

KEEP CUTTERS SHARP

Cutting Speeds for High Speed Steel Cutters

FOR CUTS UP TO ¼ INCH DEEP

Feet Per Minute	40	50	60	70	80	90	100	125
Diameter	Revolutions Per Minute							
½	306	382	459	535	611	688	764	955
⅝	245	306	367	428	489	550	612	765
¾	203	254	306	357	408	458	508	635
⅞	175	219	262	306	349	393	438	548
1	153	191	229	267	306	344	382	477
1½	102	127	153	178	204	229	255	318
2	76	95	115	134	153	172	191	238
2½	61	76	91	107	122	138	153	191
3	50	63	76	89	102	115	127	159
3½	43	54	65	76	87	98	109	136
4	38	47	57	66	76	85	95	119
4½	34	42	50	59	67	76	84	106
5	30	38	45	53	61	68	76	95
5½	27	34	41	48	55	62	69	86
6	25	31	38	44	50	57	63	79
6½	23	29	35	41	47	52	58	73
7	21	27	32	38	43	49	54	68
7½	20	25	30	35	40	45	50	63
8	19	23	28	33	38	43	47	59
9	17	21	25	29	34	38	42	53
10	15	19	22	26	30	34	38	47
11	13	17	20	24	27	31	34	43
12	12	15	19	22	25	28	31	39

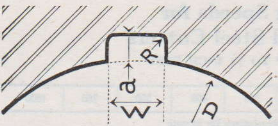
NICKEL—CHROMIUM STEEL (S.A.E. 3245)	40 to 45 FT.P.M.
NICKEL—CHROMIUM STEEL (S.A.E. 3130)	50 to 60 FT.P.M.
ANNEALED TOOL STEEL UNTREATED ALLOY STEEL	60 to 70 FT.P.M.
CAST IRON	70 to 90 FT.P.M.
SOFT MACHINE STEEL COLD ROLLED STEEL MALLEABLE CASTINGS	90 to 160 FT.P.M.
BRONZE	600 FT.P.M.
BRASS	800 FT.P.M.
ALUMINUM	1000 FT.P.M.

Cutting Speeds for High Speed Steel Cutters

FOR CUTS UP TO 1/4 INCH DEEP

Feet Per Minute	150	175	200	300	400	500	750	1000
Diameter	Revolutions Per Minute							
1/2	1146	1337	1528	2292	3056	3820	5730	7640
5/8	917	1071	1224	1836	2448	3060	5190	6120
3/4	764	889	1016	1524	2032	2540	3810	5080
7/8	655	767	875	1314	1752	2190	3285	4380
1	573	668	764	1146	1528	1910	2865	3820
1 1/2	382	445	509	764	1020	1275	1912	2550
2	286	334	382	573	764	995	1432	1910
2 1/2	229	267	305	458	611	764	1147	1530
3	191	222	254	382	509	636	952	1270
3 1/2	164	191	218	327	436	545	818	1090
4	143	167	191	286	382	477	716	955
4 1/2	127	148	169	254	339	424	636	849
5	115	133	152	229	305	382	573	764
5 1/2	104	121	138	208	277	347	521	694
6	95	111	127	191	254	318	477	636
6 1/2	88	102	117	176	235	293	440	587
7	81	95	109	163	218	272	409	545
7 1/2	76	89	101	152	203	254	382	509
8	71	83	95	143	191	238	358	477
9	63	74	84	127	169	212	318	424
10	57	66	76	114	152	191	286	382
11	52	60	69	104	138	173	260	347
12	47	55	63	95	127	159	239	318

NICKEL—CHROMIUM STEEL (S.A.E. 3245) ... 40 to 45 FT.P.M.
NICKEL—CHROMIUM STEEL (S.A.E. 3130) ... 50 to 60 FT.P.M.
ANNEALED TOOL STEEL / UNTREATED ALLOY STEEL ... 60 to 70 FT.P.M.
CAST IRON ... 70 to 90 FT.P.M.
SOFT MACHINE STEEL / COLD ROLLED STEEL / MALLEABLE CASTINGS ... 90 to 160 FT.P.M.
BRONZE ... 600 FT.P.M.
BRASS ... 800 FT.P.M.
ALUMINUM ... 1000 FT.P.M.



STANDARD KEYWAYS FOR CUTTERS

D Diameter of Hole, Inches	W Width of Keyway, Inches	A Depth of Keyway, Inches	R Radius, Inches
½	3/32	3/64	.020
⅝, ¾, ⅞	⅛	1/16	1/32
1	¼	3/32	3/64
1¼	5/16	⅛	1/16
1½	⅜	5/32	1/16
1¾	7/16	3/16	1/16
2	½	3/16	1/16
2½	⅝	7/32	1/16
3	¾	¼	3/32

LUBRICANTS FOR CUTTING TOOLS

Cutting Lubricants are used to keep the tools cool and to reduce the wear on the cutting edges, permitting fast cutting speeds.

Soluble Oil is the medium most generally used and is successful in cutting most grades of steel. It is a saponified oil, usually of a mineral oil base and readily mixes with water, the proportions of oil and water varying with the requirements.

Lard oil is highly efficient in specific cases when used in its pure or unadulterated state. It is however sometimes mixed with other oils or chemicals, for economic reasons, when it is not necessary to use it pure. Often in combination with sulphur it is highly efficient in tapping hard or tough metals. Such lubricant is called "Sulphur Base Oil."

The chart on opposite page gives an idea of the uses of cutting lubricant or coolant.

LUBRICANTS FOR CUTTING TOOLS.

Material	Drilling	Reaming	Milling	Turning	Tapping and Die Threading
Machinery Steel	Soluble Oil	Lard Oil	Soluble Oil	Soluble Oil	Soluble Oil Lard Oil
Tool Steel Carbon and High Speed	Soluble Oil or Lard Oil	Lard Oil	Soluble Oil	Soluble Oil Lard Oil	Sulphur base or Lard Oil
Alloy Steel, Forgings, etc.	Soluble Oil or Lard Oil	Lard Oil	Lard Oil	Soluble Oil Lard Oil	Sulphur base or Lard Oil
Brass	Lard Oil and Kerosene Mixture	Soluble Oil	Soluble Oil or dry	Soluble Oil	Soluble Oil or Lard Oil
Bronze	Soluble Oil or dry	Soluble Oil or dry	Soluble Oil or dry	Soluble Oil	Soluble Oil or Lard Oil
Copper	Soluble Oil	Soluble Oil	Soluble Oil or dry	Soluble Oil	Soluble Oil or Lard Oil
Aluminum	Lard Oil and Kerosene Mixture	Lard Oil	Soluble Oil or dry	Soluble Oil	Soluble Oil or Lard Oil
Monel Metal	Lard Oil	Lard Oil	Soluble Oil	Soluble Oil	Lard Oil
Malleable Iron Castings etc.	Soluble Oil	Soluble Oil	Soluble Oil	Soluble Oil	Soluble Oil
Cast Iron	Dry	Dry	Dry	Dry	Lard Oil

Involute Gear Cutters

These Cutters can be sharpened by grinding the faces of the teeth. To preserve the form of the Cutter care must be used in grinding to keep the face of each tooth radial.

To cut a set of interchangeable wheels with theoretical accuracy, as many Cutters would be required as there are different wheels in the set, for the reason that, strictly speaking, the shape of the teeth should vary with every change in the number of teeth in the wheels. As this change of form is slight and becomes less with each increase in the number of teeth, it has been found that a set of wheels ranging from a pinion of twelve teeth to a rack can be cut with sufficient accuracy for most purposes by the use of eight Cutters, as follows:

No. 1 will cut gears from	135 teeth to a rack.	
No. 2 will cut gears from	55 teeth to	134 teeth.
No. 3 will cut gears from	35 teeth to	54 teeth.
No. 4 will cut gears from	26 teeth to	34 teeth.
No. 5 will cut gears from	21 teeth to	25 teeth.
No. 6 will cut gears from	17 teeth to	20 teeth.
No. 7 will cut gears from	14 teeth to	16 teeth.
No. 8 will cut gears from	12 teeth to	13 teeth.

For work requiring still more accurate teeth a set of 15 range Cutters for each pitch is often used, using half numbers for the intermediates as follows:

No. 1	will cut gears from	135 teeth to a rack.	
No. 1½	will cut gears from	80 teeth to	134 teeth.
No. 2	will cut gears from	55 teeth to	79 teeth.
No. 2½	will cut gears from	42 teeth to	54 teeth.
No. 3	will cut gears from	35 teeth to	41 teeth.
No. 3½	will cut gears from	30 teeth to	34 teeth.
No. 4	will cut gears from	26 teeth to	29 teeth.
No. 4½	will cut gears from	23 teeth to	25 teeth.
No. 5	will cut gears from	21 teeth to	22 teeth.
No. 5½	will cut gears from	19 teeth to	20 teeth.
No. 6	will cut gears from	17 teeth to	18 teeth.
No. 6½	will cut gears from	15 teeth to	16 teeth.
No. 7	will cut gears of	14 teeth.	
No. 7½	will cut gears of	13 teeth.	
No. 8	will cut gears of	12 teeth.	

Each Cutter is marked with its number, also the diametral pitch and number of teeth for which it is adapted. In ordering, give number of Cutter and diametral pitch required.

Involute Gear Cutters

TABLE SHOWING DEPTH OF SPACE AND THICKNESS OF TOOTH IN SPUR GEARS WHEN CUT WITH THESE CUTTERS

Pitch of Cutter	Depth to be Cut in Gear, Inches	Thickness of Tooth at Pitch Line, Inches	Pitch of Cutter	Depth to be Cut in Gear, Inches	Thickness of Tooth at Pitch Line, Inches
1¼	1.726	1.257	11	.196	.143
1½	1.438	1.047	12	.180	.131
1¾	1.233	.898	14	.154	.112
2	1.079	.785	16	.135	.098
2¼	.959	.698	18	.120	.087
2½	.863	.628	20	.108	.079
2¾	784	.571	22	.098	.071
3	.719	.524	24	.090	.065
3½	.616	.449	26	.083	.060
4	.539	.393	28	.077	.056
5	.431	.314	30	.072	.052
6	.360	.262	32	.067	.049
7	.308	.224	36	.060	.044
8	.270	.196	40	.054	.039
9	.240	.175	48	.045	.033
10	.216	.157			

CUTTER CLEARANCE

Correct clearance on cutters is important and should always be considered when a cutter is being sharpened. The cutting edge only should come in contact with the work and sufficient stock should be removed back from the cutting edge so that there is no scraping or dragging action.

Tables Showing the Corresponding Diametral and Circular Pitches

The diametral pitch of a gear is the number of teeth to each inch of its pitch diameter.

The circular pitch is the distance from the center of one tooth to the center of the next tooth, measured along the pitch circle.

No. 1 table shows the diametral pitches with the corresponding circular pitches.
No. 2 table shows the circular pitches with the corresponding diametral pitches.

TABLE NO. 1

Diametral Pitch	Circular Pitch, Inches
1/2	6.283
3/4	4.188
1	3.141
1 1/4	2.513
1 1/2	2.094
1 3/4	1.795
2	1.571
2 1/4	1.396
2 1/2	1.257
2 3/4	1.142
3	1.047
3 1/2	.898
4	.785
5	.628
6	.524
7	.449
8	.393
9	.349
10	.314
11	.286
12	.262
14	.224
16	.196
18	.175
20	.157
22	.143
24	.131
26	.121
28	.112
30	.105
32	.098
36	.087
40	.079
48	.065

TABLE NO. 2

Circular Pitch, Inches	Diametral Pitch
6	.523
5	.628
4	.785
3 1/2	.897
3	1.047
2 3/4	1.142
2 1/2	1.256
2 1/4	1.396
2	1.571
1 7/8	1.676
1 3/4	1.795
1 5/8	1.933
1 1/2	2.094
1 7/16	2.185
1 3/8	2.285
1 5/16	2.394
1 1/4	2.513
1 3/16	2.646
1 1/8	2.793
1 1/16	2.957
1	3.142
15/16	3.351
7/8	3.590
13/16	3.867
3/4	4.189
11/16	4.570
5/8	5.027
9/16	5.585
1/2	6.283
7/16	7.181
3/8	8.378
5/16	10.053
1/4	12.566
3/16	16.755
1/8	25.133
1/16	50.266

TABLE OF DECIMAL EQUIVALENTS OF SCREW GAUGE

FOR MACHINE AND WOOD SCREWS.

The difference between consecutive sizes is .01316" for American Screw Co. Standard; .013" for A. S. M. E. Standard.

No. of Screw Gauge.	Size of Number in Decimals. American Screw Co. Standard.	Size of Number in Decimals. A.S.M.E. Basic and Maximm Outside Diameter	No of Screw Gauge.	Size of Number in Decimals. American Screw Co. Standard.	Size of Number in Decimals. A.S.M.E. Basic and Maximm Outside Diameter	No. of Screw Gauge.	Size of No. in Decimals. American Screw Co. Standard
000	03152		16	,26840	.268	34	.50528
00	.04468		17	.28156		35	.51844
0	.05784	.060	18	.29472	294	36	.53160
1	.07100	.073	19	.30788		37	.54476
2	.08416	.086	20	,32104	.320	38	.55792
3	.09732	.099	21	.33420		39	.57108
4	.11048	.112	22	.34736	.346	40	.58424
5	.12364	.125	23	.36052		41	.59740
6	.13680	.138	24	.37368	.372	42	.61056
7	.14996	.151	25	.38684		43	.62372
8	.16312	.164	26	.40000	.398	44	.63688
9	.17628	.177	27	.41316		45	.65004
10	.18944	.190	28	.42632	.424	46	.66320
11	.20260		29	.43948		47	.67636
12	.21576	.216	30	.45264	.450	48	.68952
13	.22892		31	.46580		49	.70268
14	.24208	.242	32	.47896		50	.71584
15	.25524		33	.49212			

THE U. S. STANDARD GAUGE FOR SHEET AND PLATE IRON AND STEEL, 1893.

There is in this country no uniform or standard gauge, and the same numbers in different gauges represent different thicknesses of sheets or plates. This has given rise to much misunderstanding and friction between employers and workmen and mistakes and frauds between dealers and consumers.

An Act of Congress in 1893 established the Standard Gauge for sheet iron and steel which is given on next page. It is based on the fact that a cubic foot of iron weighs 480 pounds.

A sheet of iron 1 foot square and 1 inch thick weighs 40 pounds, or 640 ounces, and 1 ounce in weight should be 1-640 inch thick. The scale has been arranged so that each descriptive number represents a certain number of ounces in weight and an equal number of 640ths of an inch in thickness.

The law enacts that on and after July 1, 1893, the new gauge shall be used in determining duties and taxes levied on sheet and plate iron and steel; and that in its application a variation of 2½ per cent. either way may be allowed.

See pages 51 and 52.

U. S. STANDARD GAUGE FOR SHEET AND PLATE IRON AND STEEL, 1893.

TAKEN FROM KENT'S MECHANICAL ENGINEERS' POCKET-BOOK.

Number of Gauge.	Approximate Thickness in Fractions of an Inch.	Approximate Thickness in Decimal Parts of an Inch.	Approximate Thickness in Millimeters.	Weight per Square Foot in Ounces Avoirdupois.	Weight per Square Foot in Pounds Avoirdupois.	Weight per Square Foot in Kilograms.	Weight per Square Meter in Kilograms.	Weight per Square Meter in Pounds Avoirdupois.
0000000	1-2	0.5	12.7	320	20.	9.072	97.65	215.28
000000	15-32	0.46875	11.90625	300	18.75	8.505	91.55	201.82
00000	7-16	0.4375	11.1125	280	17.50	7.938	85.44	188.37
0000	13-32	0.40625	10.31875	260	16.25	7.371	79.33	174.91
000	3-8	0.375	9.525	240	15.	6.804	73.24	161.46
00	11-32	0.34375	8.73125	220	13.75	6.237	67.13	148.00
0	5-16	0.3125	7.9375	200	12.50	5.67	61.03	134.55
1	9-32	0.28125	7.14375	180	11.25	5.103	54.93	121.09
2	17-64	0.265625	6.746875	170	10.625	4.819	51.88	114.37
3	1-4	0.25	6.35	160	10.	4.536	48.82	107.64
4	15-64	0.234375	5.953125	150	9.375	4.252	45.77	100.91
5	7-32	0.21875	5.55625	140	8.75	3.969	42.72	94.18
6	13-64	0.203125	5.159375	130	8.125	3.685	39.67	87.45
7	3-16	0.1875	4.7625	120	7.5	3.402	36.62	80.72
8	11-64	0.171875	4.365625	110	6.875	3.118	33.57	74.00
9	5-32	0.15625	3.96875	100	6.25	2.835	30.52	67 27
10	9-64	0.140625	3.571875	90	5.625	2.552	27.46	60.55
11	1-8	0.125	3.175	80	5.	2.268	24.41	53.82
12	7-64	0.109375	2.778125	70	4.375	1.984	21.36	47.09
13	3-32	0.09375	2.38125	60	3.75	1.701	18.31	40.36
14	5-64	0.078125	1.984375	50	3.125	1.417	15.26	33.64
15	9-128	0.0703125	1.7859375	45	2.8125	1.276	13.73	30.27
16	1-16	0.0625	1.5875	40	2.5	1.134	12.21	26 91

U. S. STANDARD GAUGE FOR SHEET AND PLATE IRON AND STEEL, 1893.

TAKEN FROM KENT'S MECHANICAL ENGINEERS' POCKET-BOOK.

Number of Gauge	Approximate Thickness in Fractions of an Inch.	Approximate Thickness in Decimal Parts of an Inch.	Approximate Thickness in Millimeters.	Weight per Square Foot in Ounces Avoirdupois.	Weight per Square Foot in Pounds Avoirdupois.	Weight per Square Foot in Kilograms.	Weight per Square Meter in Kilograms	Weight per Square Meter in Pounds Avoirdupois.
17	9-160	0.05625	1.42875	36	2.25	1.021	10.99	24.22
18	1-20	0.05	1.27	32	2.	0.9072	9.765	21.53
19	7-160	0.04375	1.11125	28	1.75	0.7938	8.541	18.84
20	3-80	0.0375	0.9525	24	1.50	0.6804	7.324	16.15
21	11-320	0.034375	0.873125	22	1.375	0.6237	6.713	14.80
22	1-32	0.03125	0.793750	20	1.25	0.567	6.103	13.46
23	9-320	0.028125	0.714375	18	1.125	0.5103	5.49	12.11
24	1-40	0.025	0.635	16	1.	0.4536	4.882	10.76
25	7-320	0.021875	0.555625	14	0.875	0.3969	4.272	9.42
26	3-160	0.01875	0.47625	12	0.75	0.3402	3.662	8.07
27	11-640	0.0171875	0.4365625	11	0.6875	0.3119	3.357	7.40
28	1-64	0.015625	0.396875	10	0.625	0.2835	3.052	6.73
29	9-640	0.0140625	0.3571875	9	0.5625	0.2551	2.746	6.05
30	1-80	0.0125	0.3175	8	0.5	0.2268	2.441	5.38
31	7-640	0.0109375	0.2778125	7	0.4375	0.1984	2.136	4.71
32	13-1280	0.01015625	0.25796875	6½	0.40625	0.1843	1.983	4.37
33	3-320	0.009375	0.238125	6	0.375	0.1701	1.831	4.04
34	11-1280	0.00859375	0.21828125	5½	0.34375	0.1559	1.678	3.70
35	5-640	0.0078125	0.1984375	5	0.3125	0.1417	1.526	3.36
36	9-1280	0.00703125	0.17859375	4½	0.28125	0.1276	1 373	3.03
37	17-2560	0.00664062	0.16867187	4¼	0.26562	0.1205	1.297	2.87
38	1-160	0.00625	0.15875	4	0.25	0.1134	1.221	2.69

Weights of Square and Round Steel Bars

IN POUNDS PER LINEAR FOOT

STEEL WEIGHING 489.6 LBS. PER CUBIC FOOT

FOR IRON SUBTRACT 2 PER CENT

Size Inches	Weight, Pounds Per Linear Foot		Size Inches	Weight, Pounds Per Linear Foot	
	Square	Round		Square	Round
1/16	.013	.010	2 1/16	14.46	11.36
1/8	.053	.042	1/8	15.35	12.06
3/16	.120	.094	3/16	16.27	12.78
1/4	.213	.167	1/4	17.21	13.52
5/16	.332	.261	5/16	18.18	14.28
3/8	.478	.376	3/8	19.18	15.06
7/16	.651	.511	7/16	20.20	15.86
1/2	.850	.668	1/2	21.25	16.69
9/16	1.076	.845	9/16	22.33	17.53
5/8	1.328	1.043	5/8	23.43	18.40
11/16	1.607	1.262	11/16	24.56	19.29
3/4	1.913	1.502	3/4	25.71	20.20
13/16	2.245	1.763	13/16	26.90	21.12
7/8	2.603	2.044	7/8	28.10	22.07
15/16	2.988	2.347	15/16	29.34	23.04
1	3.400	2.670	3	30.60	24.03
1/16	3.838	3.015	1/16	31.89	25.05
1/8	4.303	3.380	1/8	33.20	26.08
3/16	4.795	3.766	3/16	34.54	27.13
1/4	5.313	4.172	1/4	35.91	28.21
5/16	5.857	4.600	5/16	37.31	29.30
3/8	6.428	5.049	3/8	38.73	30.42
7/16	7.026	5.518	7/16	40.18	31.55
1/2	7.650	6.008	1/2	41.65	32.71
9/16	8.301	6.519	9/16	43.15	33.89
5/8	8.978	7.051	5/8	44.68	35.09
11/16	9.682	7.604	11/16	46.23	36.31
3/4	10.413	8.178	3/4	47.81	37.55
13/16	11.170	8.773	13/16	49.42	38.81
7/8	11.953	9.388	7/8	51.05	40.10
15/16	12.763	10.024	15/16	52.71	41.40
2	13.600	10.681	4	54.40	42.73

Weights of Square and Round Steel Bars

IN POUNDS PER LINEAR FOOT

STEEL WEIGHING 489.6 LBS. PER CUBIC FOOT

FOR IRON SUBTRACT 2 PER CENT

(Continued)

Size Inches	Weight, Pounds Per Linear Foot		Size Inches	Weight, Pounds Per Linear Foot	
	Square	Round		Square	Round
4 1/16	56.11	44.07	6 1/8	127.6	100.2
1/8	57.85	45.44	1/4	132.8	104 3
3/16	59.62	46.83	3/8	138.2	108.5
1/4	61.41	48.23	1/2	143.7	112.8
5/16	63.23	49.66	5/8	149.2	117.2
3/8	65.08	51.11	3/4	154.9	121.7
7/16	66.95	52.58	7/8	160.7	126.2
1/2	68.85	54.07	7	166.6	130.9
9/16	70.78	55.59	1/8	172.6	135.6
5/8	72.73	57.12	1/4	178.7	140.4
11/16	74.71	58.67	3/8	184.9	145.2
3/4	76.71	60.25	1/2	191.3	150.2
13/16	78.74	61.85	5/8	197.7	155.3
7/8	80.80	63.46	3/4	204.2	160.4
15/16	82.89	65.10	7/8	210.9	165.6
5	85.0	66.8	8	217.6	170.9
1/16	87.1	68.4	1/4	231.4	181.8
1/8	89.3	70.1	1/2	245.7	192.9
3/16	91.5	71.9	3/4	260.3	204.5
1/4	93.7	73.6	9	275.4	216.3
5/16	96.0	75.4	1/4	290.9	228.5
3/8	98.2	77.2	1/2	306.9	241.0
7/16	100.5	79.0	3/4	323.2	253.9
1/2	102.9	80.8	10	340.0	267.0
9/16	105.2	82.6	1/4	357.2	280.6
5/8	107.6	84.5	1/2	374.9	294.4
11/16	110.0	86.4	3/4	392.9	308.6
3/4	112.4	88.3	11	411.4	323.1
13/16	114.9	90.2	1/4	430.3	338.0
7/8	117.4	92.2	1/2	449.7	353.2
15/16	119.9	94.1	3/4	469.4	368.7
6	122.4	96.1	12	489.6	384.5

WEIGHT OF IRON AND STEEL SHEETS

WEIGHTS PER SQUARE FOOT

TAKEN FROM KENT'S MECHANICAL ENGINEER'S POCKET BOOK

FOR HIGH SPEED STEEL ADD APPROXIMATELY 10 PER CENT TO "STEEL" WEIGHTS.

Thickness by Birmingham Gauge.				Thickness by Birmingham Gauge.			
Number of Gauge.	Thickness in Inches.	Iron.	Steel.	Number of Gauge.	Thickness in Inches.	Iron.	Steel.
0000	.454	18.16	18.52	17	.058	2.32	2.37
000	.425	17.00	17.34	18	.049	1.96	2.00
00	.38	15.20	15.50	19	.042	1.68	1.71
0	.34	13.60	13.87	20	.035	1.40	1.43
1	.3	12.00	12.24	21	.032	1.28	1.31
2	.284	11.36	11.59	22	.028	1.12	1.14
3	.259	10.36	10.57	23	.025	1.00	1.02
4	.238	9.52	9.71	24	.022	.88	.898
5	.22	8.80	8.98	25	.02	.80	.816
6	.203	8.12	8.28	26	.018	.72	.734
7	.18	7.20	7.34	27	.016	.64	.653
8	.165	6.60	6.73	28	.014	.56	.571
9	.148	5.92	6.04	29	.013	.52	.530
10	.134	5.36	5.47	30	.012	.48	.490
11	.12	4.80	4.90	31	.01	.40	.408
12	.109	4.36	4.45	32	.009	.36	.367
13	.095	3.80	3.88	33	.008	.32	.326
14	.083	3.32	3.39	34	.007	.28	.286
15	.072	2.88	2.94	35	.005	.20	.204
16	.065	2.60	2.65	36	.004	.16	.163

	Iron	Steel
Specific Gravity	7.7	7.854
Weight per Cubic Foot	480	489.6
Weight per Cubic Inch	.2778	.2833

USEFUL RULES FOR FINDING DIMENSIONS OF CIRCLES, SQUARES, ETC.

D is diameter of stock necessary to turn shape desired.

A is distance "across flats."

C is depth of cut into stock turned to correct diameter.

TRIANGLE.

A = side x .57735
D = side x 1.1547 = 2A
Side = D x .866
C = A x .5 = D x .25

SQUARE.

A = side = D x .7071
D = side x 1.4142 = diagonal
Side = D x .7071
C = D x .14645

PENTAGON.

A = side x 1.3764 = D x .809
D = side x 1.7013 = A x 1.2361
Side = D x .5878
C = D x .0955

HEXAGON.

A = side x 1.7321 = D x .866
D = side x 2 = A x 1.1547
Side = D x .5
C = D x .067

OCTAGON.

A = side x 2.4142 = D x .9239
D = side x 2.6131 = A x 1.0824
Side = D x .3827
C = D x .038

CALCULATING PULLEY SPEEDS

Dr = Diameter in inches of DRIVING pulley.
Dn = Diameter in inches of DRIVEN pulley.
S = SPEED in revolutions per minute of driving shaft.
R = SPEED in revolutions per minute of driven shaft.

Problem 1

Given, Dr, Dn and S — find R.

Rule, $R = \frac{Dr \times S}{Dn}$

Example, — Given, diameter of pulley on driving shaft, 30 inches; given, speed of driving shaft, 150; given, diameter of driven pulley, 10 inches; find the speed of the driven shaft.
Dr = 30; S = 150; Dn = 10; 30 multiplied by 150 gives 4,500; this product divided by 10 gives 450, the resulting speed of the driven shaft.

Problem 2

Given, Dr, S and R — find Dn.

Rule, $Dn = \frac{Dr \times S}{R}$

Problem 3

Given, Dr, Dn and R — Find S.

Rule, $S = \frac{Dn \times R}{Dr}$

Problem 4

Given, Dn, R and S — Find Dr.

Rule, $Dr = \frac{Dn \times R}{S}$

In calculating for speed of gears, multiply or divide by either the diameter in inches or by the number of teeth.

RULE FOR FINDING LENGTH OF BELT FOR TWO PULLEYS

Add the diameters in inches of the two pulleys and multiply this sum by 1.57; to this product add twice the distance, in inches, between the centers of the two shafts. The result is the approximate length of the belt in inches.

LENGTH OF BELTING IN ROLLS

Diameter of roll in inches plus diameter of hole multiplied by number of laps, multiplied by .1309, gives length of belt in feet.

USEFUL CONSTANTS

To find circumference of a circle multiply diameter by 3.14159265359; 3.1416 is commonly used, as is $3\frac{1}{7}$ or $\frac{22}{7}$ for rough work; $\frac{355}{113}$ as a multiplier is easily remembered and is accurate to six places of decimals.

To find diameter of a circle multiply circumference by .31831.

To find area of a circle multiply square of diameter by .7854.

To find side of an equal square multiply diameter by .88623.

To find side of an inscribed square multiply diameter by .7071.

To find diameter of an equal circle multiply side of square by 1.1284.

To find the surface of a ball or sphere multiply the square of the diameter by 3.1416.

To find the contents or number of cubic inches in a ball multiply the cube of the diameter by .5236.

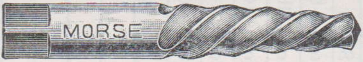
A gallon of water, U.S. Standard, weighs $8\frac{1}{3}$ lbs. and contains 231 cubic inches.

A cubic foot of water contains $7\frac{1}{2}$ gallons and weighs 62.4 lbs.

To find the pressure in pounds *per square inch* of a column of water multiply the height of the column in feet by .433.

The simplest way out of a difficult problem

THE MORSE SCREW EXTRACTOR



No. 773

To remove a broken screw, simply drill a hole in it and insert the screw extractor turning it to the left. The left hand spiral edges of the extractor grip the screw securely and permit you to remove it easily on its own threads — and without damage to the threads of the hole.

Here is the workmanlike way of handling an otherwise bothersome and expensive job. The MORSE screw extractor puts an end to time-wasting fussing with punches, files and drifts.

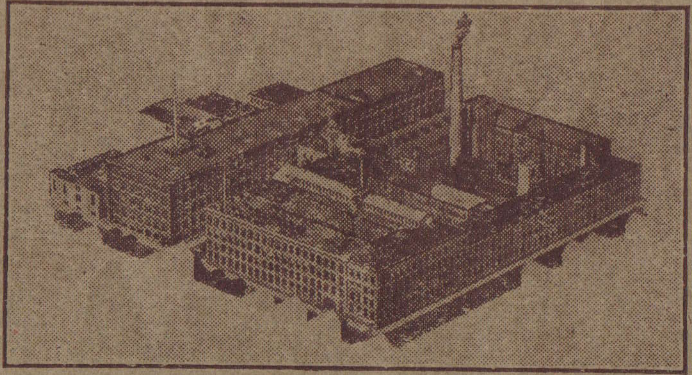
Every shop should be equipped with this handy method. The time saved on a single job frequently more than pays for the purchase price of this tool.

Morse screw Extractors are available in twelve sizes covering every need for machine shop, automotive service and oil well work. Five sets of extractors are offered — the choice of which should be dictated by the sizes of screws most commonly encountered.

See next page

EXTRACTOR SIZE
For Screw and Pipe Sizes

Extractor Size	Dia. at Sm. End	Dia. at Lg. End	Size of Drill to Use	Screw Sizes: Fractional	Screw Sizes: Mch Screw	Pipe Sizes
1	.054	.117	5/64	1/16 to 9/64	No 0 to No. 6	
2	.080	.174	7/64	5/32 to 3/16	7 to 10	
3	1/8	1/4	5/32	13/64 to 1/4	12 to 16	
4	3/16	11/32	1/4	5/16 to 3/8	18 to 24	
5	1/4	7/16	17/64	7/16 to 1/2	26 to 30	1/8 and 1/4
6	3/8	19/32	13/32	9/16 to 11/16		3/8
7	1/2	3/4	17/32	3/4 to 7/8		1/2
8	3/4	1 1/64	13/16	1 to 1 1/4		3/4
9	1	1 9/32	1 1/16	1 3/8 to 1 1/2		1
10	1 1/4	1 9/16	1 5/16	1 3/4 to 2		1 1/4
11	1 1/2	1 7/8	1 9/16	2 1/4		1 1/2
12	1 7/8	2 5/16	1 15/16	2 1/2		2



WORKS OF THE MORSE TWIST DRILL & MACHINE CO.

NEW BEDFORD, MASS., U. S. A.